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DEVELOPMENT OF A PERSON-PORTABLE ANALYTICAL SYSTEM FOR ENVIRONMENTAL EMERGENCIES

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DEVELOPMENT OF A PERSON-PORTABLE ANALYTICAL SYSTEM FOR ENVIRONMENTAL EMERGENCIES

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ABSTRACT

Person-portable analytical systems for air, water, and soil analysis are being developed for use at chemical spill sites. The OVA 128 and the HNU PI 101, the selected instruments for spill site air monitoring, were calibrated for a number of priority hazardous substances. Calibration data was obtained by analyzing static test atmospheres of each priority chemical at selected ppm concentration levels. Additional work is required to develop these instruments to their maximum potential for spill site use. The Hach DR-EL/4 system, selected for water and soil analysis applications, has undergone laboratory evaluation. Hach kit applications are presently limited to the analysis of common inorganic species in water. Hach kit technology may be applicable, in some cases, to the analysis of priority substances in soil, and priority organic substances in water. These areas of potential application have not yet been investigated experimentally.

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CONCLUSIONS

The main conclusions drawn from the 1983/84 development work on person-portable analytical systems for chemical spill site monitoring are as follows:

1. OVA 128 Relative Response Factors for EETD priority substances were generally in line with expectations, although instrument to instrument variations in relative response were larger than expected.

2. OVA response was linear for all organics, at least to concentrations resulting in scale readings of 100 or less. For some unknown reason, possibly electronics-related, enhanced readings were generally obtained on the OVA's X100 Range setting.

3. Additional work is still required to develop the OVA to maximum field-use potential. Secondary calibrations remain to be conducted for approximately 20 priority substances to which the OVA will respond.

4. Secondary calibration meter scales should not be based solely on the data contained in this report since the typical magnitude of instrument to instrument variation in relative response cannot be defined with data from only three OVA units.

5. HNU PI 101 response appears to be inherently non-linear for all compounds to which this instrument will respond. The degree of non-linearity varies from compound to compound such that a response factor for any individual compound relative to the primary calibrant substance cannot be defined.

6. HNU instrument to instrument variations appear to be less significant than was the case with the OVA. Therefore, it should be possible to prepare calibration scales for EETD priority substances based on comparative data obtained with four HNU units.

7. Additional work will be required to develop the HNU to maximum field-use potential. Secondary calibrations remain to be conducted for many priority substances to which the HNU will respond.

8. The preparation of HNU meter concentration scales for individual priority chemicals will require careful, and probably tedious, interpretation of the non-linear calibration data obtained. Also, the preparation of meter scales would best be deferred until it is decided how best to utilize the HNU's variable Span feature for field work.

9. OVA sensitivity (i.e. slope of the response curve) is generally far superior to HNU sensitivity at high concentration levels.

10. Hach kit methods for water analysis should be capable of generating field test results of sufficient accuracy over the specified concentration range for individual test factors. This conclusion will apply only if the Hach kit is used consistently under specified conditions. These conditions must be generally defined in a Hach kit Field Manual.

11. There exists wide scope for development in the area of spill site monitoring of water and soil at the person-portable level of analytical sophistication. In terms of water analysis for priority list organic substances, and soil analysis for all priority test substances, few methods exist which are compatible with the criteria outlined in this report.

12. The development of EETD person-portable analytical systems has not yet reached the stage where a comprehensive Field Manual can be prepared for any of the three systems.

RECOMMENDATIONS

Based on the results of 1983/84 development work on the OVA, HNU, and Hach systems, the following recommendations are made:

1. Secondary calibrations of the OVA and HNU systems should be carried out for the remaining EETD priority substances (approximately 20) to which these systems will respond.

2. Secondary calibrations should be conducted according to the experimental procedures established during this study, and described in this report.

3. The typical magnitude of OVA to OVA variations in relative response should be determined by conducting secondary calibrations for a few selected chemicals using all 9 available OVA's. This information is necessary if the most accurate possible OVA calibration scales are to be prepared.

4. The possible effect of temperature on OVA and HNU performance and accuracy should be assessed from observations made during tests conducted inside a laboratory environmental chamber.

5. Possible options related to ensuring accurate field calibration of the OVA and HNU should be explored.

6. Attempts should be made to develop relatively simple methods for the analysis of priority list substances in soil, and priority organic substances in water. If possible, these methods should incorporate the use of Hach technology and reagents.

7. Soil samples contaminated with water-insoluble priority list inorganics should, for personnel safety reasons among others, be analyzed at a home-base laboratory.

1 INTRODUCTION

1.1 GENERAL

Following a chemical spill incident, rapid implementation of the correct response measures requires:

1) A knowledge of the chemical, physical, toxicological and environmental properties of the substance(s) involved, and
2) Rapid and sufficiently accurate determination of air, water, and soil concentrations of the chemical(s) in the vicinity of the spill site.

Recognizing that these requirements were not being adequately met in most spill situations, Environment Canada launched, in 1980, a comprehensive program to develop spill response capabilities. Responsibility for directing the development of the Chemical Hazards Emergency Countermeasures (CHEC) program resides with the Environmental Emergencies Technology Division (EETD) of the Environmental Protection Service (EPS).

In order to focus the development of the CHEC program on appropriate targets, a priority list of 150 chemical substances or groups was developed by the EETD (1) and is included as Appendix C of this report. From the most recent data available, these chemicals are known to account for over 90 % of the reported spills and well over 90 % of the spill volume in Canada.

One of the first tasks undertaken in the development of analytical capability for a spill response program was an assessment of the potential applicability of existing analytical systems. Based on criteria of portability, accuracy, and range of coverage, existing capability was divided into five levels, designated as Level 1 to Level 5. Levels 1, 2, and 3 were considered most appropriate for spill monitoring. This report focuses on the development of Level 2 analytical systems, which are generally defined as person-portable systems having electronic detectors.

Instruments compatible with Level 2 criteria were selected in 1980/81, and development work on the selected instruments was carried out by a previous contractor between 1981 and March, 1983. The authors have advanced the development of Level 2 systems, beginning in late May, 1983, and continuing up to the time of this report.

1.2 LEVEL 2 CONCEPTS AND CRITERIA

Person-portable analytical systems obviously will lack the sophistication associated with the typical fixed laboratory instrumentation. Although many Level 2 systems for air monitoring are non-specific with respect to substances detected, this does not represent a serious drawback since, in many spill situations, only one hazardous substance is involved, and concentration levels of this substance are likely to far exceed levels of potential interferences in the ambient background. Furthermore, the spilled substance is often easily identifiable from shipping documents or from evidence at the scene.

The electronic detection, direct readout requirement for Level 2 systems minimizes operator subjectivity in interpreting results. Important criteria to be met by Level 2 systems include:

1. rapidity in obtaining results
2. accuracy
3. ability to provide detection limits below maximum allowable limits for a wide range of hazardous substances of interest.
4. simplicity of use and maintenance
5. adaptable for use over a wide range of climatic conditions.
6. long-life self-contained power source
7. moderate cost to allow for wide distribution across Canada

Given the frequency of spill incidents, the varying degrees of immediate human and environmental impact represented by such incidents, and the high probability that a specific spill location is remote from the location of vehicle-portable Level 3 systems, it is obvious that the typical spill situation must be handled by Level 1 and Level 2 analytical systems standing alone. Also, since these systems are likely to be operated frequently by field

personnel with little background in chemistry, it is important to understand and minimize the effect of design and performance, chemical, environmental, and human factors which contribute to error. Accuracy of results with Level 2 systems will depend on the following:

1. accuracy of calibration or standardization
2. inherent stability of instrument response
3. proper maintenance of equipment
4. chemical interferences
5. reagent shelf-life
6. ambient environmental conditions at the spill site
7. training of field personnel, following thorough laboratory evaluation of systems
8. quality of Field Manuals

We see Level 2 systems as being applicable to air, water, and (with some reservations) soil analysis. Level 2 development priorities should be in accordance with the order of media priority. Air is generally the medium associated with the greatest immediate potential hazard in spill situations, while water ranks second. Soil/sediment analysis is seen as being useful for defining spill perimeters and monitoring the progress of cleanup operations such as excavation or dredging.

1.3 SELECTED LEVEL 2 ANALYTICAL SYSTEMS

Having developed Level 2 concepts and criteria as well as the priority chemicals list, the EETD proceeded to assess the potential application of commercially available analytical instrumentation to spill site use. For various reasons, very few instruments currently on the market were of any potential use. Also, it was clear from this assessment that those systems which did show Level 2 potential would require extensive laboratory development work before they could be considered field-ready.

A large number of instruments designed for air monitoring applications and satisfying some Level 2 criteria are on the market (2). The major shortcoming of many of these instruments in terms of the priority chemicals list is range

of coverage. A few instruments are calibrated for one substance but have broad potential application. A small subgroup of these instruments satisfy the majority of Level 2 criteria. The instruments selected by the EETD for spill site air monitoring were the Foxboro Model 128 Organic Vapor Analyzer (OVA) plus the HNU Systems Inc. Model PI 101 Photoionization Analyzer.

For water analyses, the few commercially available systems which are compatible to some degree with Level 2 criteria are similar in that coverage is basically restricted to inorganic species, and for a given species, the same well-established colourimetric, titrimetric, or turbidimetric methodology is employed by all systems.

Available systems differ, however, in range of coverage for priority chemicals and general sophistication. For priority chemicals in spill site soil, a suitable analytical system is not commercially available. However, if we accept a lower accuracy, many of the existing Level 2 water analysis methods also will apply to soil analysis if the soil sample is first extracted with water. The EETD has selected the Hach Chemical Company's DR-EL/4 Portable Laboratory as the analytical system with the greatest potential application as a Level 2 system for water and soil analysis.

Following is a brief description and discussion of each of the selected Level 2 analytical systems.

1.3.1 OVA 128

The OVA 128 is basically a portable flame ionization detector designed for one-man, one-hand operation and weighing approximately 5 kg. Operating in the "sniffer mode", a continuous metered flow of sample air is pumped into the detector chamber where organic molecules are burned in a hydrogen flame, producing positively-charged carbon-containing ions. The current produced by these ions is amplified and displayed as a parts per million reading on the meter of the hand-held readout assembly.

In the "sniffer mode", the detector responds to all organic chemicals in the sample air. As mentioned earlier, this lack of specificity should not

seriously affect the accuracy of results in most spill monitoring situations. The OVA 128 may also be operated in the Gas Chromatography (GC) mode if more than one organic compound is present in the air at concentration levels which would seriously affect the accuracy of results for the pollutant of interest when the OVA is operated in the sniffer mode.

The OVA's hydrogen supply and rechargeable 12 VDC battery allow for a minimum of 8 hours of continuous operation. A strip chart recorder is available as an option.

The OVA is factory-calibrated for methane and linearly measures concentrations of this compound over the range of 0.1 to 1000 ppm. Response for other priority organic chemicals must be determined empirically. The OVA is capable of monitoring concentrations below the Threshold Limit Value (TLV) for the great majority of organic chemicals on the EETD priority chemicals list.

1.3.2 HNU PI 101

The HNU is an elegantly-designed detector unit which consumes no gases and weighs approximately 4 kg. Detection of chemicals in air is based on the principle of photo-ionization. During operation, a continuous flow of sample air is drawn by a DC - operated fan into an ionization chamber located in the hand-held probe. Photons emitted by the 10.2 eV UV source pass through a transmitting window into the ionization chamber where this radiation is absorbed by molecules having ionization potentials of 10.2 eV or less (although substances with slightly higher ionization potentials typically produce an instrument response also). The positive ions produced by this process generate a current proportional to the concentration of the sample substance in air. This current is amplified and used to drive an analog meter on the readout unit.

The HNU in a selective detector, since chemicals having ionization potentials much greater than 10.2 eV will not produce an instrument response. The HNU will not respond to the major constituents of air. This instrument will, however, detect a broad range of organic compounds, as well as a few inorganic compounds such as H_2S and NO_2.

Similar to the OVA, the HNU utilizes a rechargeable battery which allows for 10 hours of continuous service, or 5 hours of continuous service if the optional strip chart recorder is used.

The 10.2 eV HNU is factory-calibrated for benzene. Manufacturer's literature claims linear response over a range of 0.1 to 600 ppm for many chemicals, although, like the OVA, the HNU must be calibrated for each priority chemical of interest to which it will respond. The maximum reading possible with the HNU is 2000, although such a high reading would not be linearly-related to the actual concentration of the chemical producing it.

Both the HNU and OVA feature a ten-turn dial-readout potentiometer control (span control) for setting amplifier gain. This feature enhances the ability of these instruments to monitor low concentration levels.

1.3.3 HACH DR-EL/4

The HACH DR-EL/4 is the most analytically sophisticated Level 2 system for water analysis on the market, and provides a broader coverage for EETD priority inorganic chemicals compared to competitive systems.

The HACH kit encompasses a large number of water quality tests normally performed on a routine basis at municipal and industrial water treatment facilities. HACH methods are generally based upon well established colourimetric, titrimetric, and turbidimetric reactions. After purchasing the basic kit consisting of a single-beam, portable spectrophotometer (conductivity feature optional), digital pH meter, digital titrator (micro-buret) and common labware, one need only purchase those chemicals and pre-standardized reagents required for the test factors of interest. A large number of dry reagents are available in single-dose form, conveniently sealed inside polyethylene "powder pillows" which are opened with ordinary nail clippers. Calibrated meter scales are provided for all test factors which require spectrophotometric analysis.

HACH technology minimizes the skill and technique factor typical of wet-chemical analyses to the point where water quality tests can be reliably performed by non-technical personnel. This feature, combined with the direct read-out capability and portability of the kit makes the HACH DR-EL/4 an attractive Level 2 system for spill response applications.

1.4 ANALYTICAL DEVELOPMENT STATUS, MAY, 1983

1.4.1 OVA 128 and HNU PI 101

The previous contractor attempted to calibrate OVA and HNU units for a large number of EETD priority chemicals. Unfortunately, it is clear that their attempts were unsuccessful. Reports and data relating to this previous work revealed fatal flaws in the design and execution of the experimental work. Major deficiencies in this work are briefly described below.

Static test atmospheres of priority chemicals in air over a selected range of concentration were prepared in aluminized Mylar bags. Nominal test sample concentrations were calculated from the amount of the chemical injected into the bag and the volume of air contained in the bag. The method of measuring the volume of air introduced into a bag was not reported. It was reported, however, that microliter quantities of the chemicals of interest were injected into a stream of air while bags were being filled. While important details of this procedure which would relate to the accuracy of prepared sample concentrations were not reported, this approach to the preparation of static test atmospheres is likely to lead to actual vapor concentrations which are below calculated nominal concentrations for all but the most volatile of chemicals, especially when opaque aluminized Mylar bags are used.

Some chemicals which have high vapor pressures at ambient temperature evaporate relatively slowly, i.e. the time required to achieve a known vapor concentration depends on factors other than vapor pressure. With aluminized Mylar it is not possible to observe whether all of the sample injected into the bag or air stream has vaporized (fast injection), or whether a droplet of liquid, possibly representing a significant percentage of the total injection volume, is adhering to the tip of the syringe needle as the needle is

withdrawn through the bag septum (slow injection).

A second major deficiency of the previous calibration work was that no data relating to the accuracy or day to day variability of OVA/HNU primary calibration was reported. Primary calibration data is essential in order to determine normal limits of variability in instrument performance (e.g. accuracy and stability of calibration). Without primary calibration data, mechanical problems such as leaks or restrictions, which can seriously affect response, may go undetected. Also, by definition, primary calibration data is necessary in order to calculate relative response factors for other chemicals.

The factors described above, plus others not commented on here, are reflected in the secondary calibration data and calculated relative response factors derived from the previous experimental work. Large instrument to instrument variations which were inconsistent in magnitude from compound to compound were reported. Inaccurate primary calibration and undiagnosed mechanical problems were likely contributors to the apparent variations, although no possible explanations were offered.

Poor sample preparation methodology is likely to have contributed to results which were often very low compared to approximate relative response factors reported by the instrument manufacturers. There were many extreme cases where priority substances were reported to produce no instrument response although some response, and in some cases a large response, would be expected. With the OVA, vinyl chloride was not detected at a nominal concentration of 25 ppm. Propylene glycol, which vaporizes very slowly, did not produce a response at a reported nominal concentration of 1000 ppm, which actually far exceeds the attainable vapor concentration of this compound under ambient conditions.

With the HNU, no response was reported for vapor samples of the following compounds (ionization potentials in brackets):

Acetic acid	(10.37)
Dimethyl amine	(8.24)
Monomethyl amine	(8.97)
Styrene	(8.47)
Propylene oxide	(10.22)
Trimethyl amine	(7.82)
Vinyl chloride	(9.995)

Given the shortcomings in the design and execution of the previous development work on the OVA and HNU systems, it was necessary to repeat this work over the course of the present contract. Secondary calibration data from this year's work are reported in Appendices A and B of this report, and discussed in Section 2.

1.4.2 HACH DR-EL/4

Hach kit development work to May, 1983 was aimed at confirming that Hach methodology was capable of delivering consistent and accurate results with laboratory test solutions of various pure inorganic substances in deionized water, within the concentration ranges specified for individual test factors. Hach pH meter performance was evaluated, and tests were carried out for two bulk properties (acidity and alkalinity), 17 inorganic species, and phenol. The group of test methods evaluated represents capability to analyze for nearly all EETD priority inorganic substances in water. In many cases, e.g. ammonium nitrate and aluminum sulfate, capability exists for analyzing both the cation and the anion.

Hach kit methods for potassium, sulfite, arsenic and zinc were not evaluated, but are applicable to the analysis of potassium hydroxide, potassium sulfate, sodium sulfite, sodium arsenite, zinc chloride, and zinc sulfate, all EETD priority substances.

There is little to question in terms of the actual test data reported for the Hach kit evaluation. One comment which applies to most of the reported test results is that methods were tested only at the maximum limit of the specified applicable concentration range. However, it is also important to know the potential accuracy of a method at the lower end of the specified concentration range. Therefore, over the course of the present contract we have repeated the evaluation of several test methods at multiple concentrations.

We agree with most of the general conclusions from the previous work which relate to field use of Hach kit methods. However, we disagree that high dilution factors, which may be necessary to bring the concentration level of an analyte of interest into a method's applicable concentration range, would necessarily have a serious adverse effect on accuracy. With proper equipment and instruction, field personnel should be capable of making very accurate dilutions.

Several non-Hach methods were proposed for the analysis of water-insoluble priority inorganic compounds in soil/sediment samples. Applicable concentration ranges were reported to be 0 to 100 % for each method. Such methods may have some potential with respect to the analysis of sediment samples, but would not apply to the analysis of soil samples. Soil, rather than sediment analysis is likely to be called for in the typical spill incident. It is pointless to analyze a soil sample when the concentration of the known contaminant is so high as to be visible to the naked eye.

Since the purpose of soil/sediment analysis would be to define spill perimeters and to moniter the progress of cleanup operations, samples would be expected to contain low percentage levels of contaminant. The methods proposed in previous work would lack the necessary sensitivity for accurate analysis at such concentration levels.

Limitations relating to the analysis of water-insoluble inorganic substance in soil/sediment are more fully discussed later in this report.

2. RESULTS AND DISCUSSION OF RECENT DEVELOPMENT WORK

2.1 OVA 128 AND HNU PI 101

Analytical development work on Level 2 air monitoring systems during 1983/84 consisted of the secondary calibration of 3 OVA and 4 HNU units to 32 and 26 priority organic chemicals respectively. The primary calibration of each unit was monitored on a day to day basis. The linearity of HNU response to its primary calibrant, benzene, was also investigated.

Details relating to the design and execution of secondary calibration experiments are reported in the following sections.

2.1.1 Sample Preparation and Analysis

The secondary calibration data reported in Appendices A and B are results from the sampling of static test atmospheres for each compound at several concentration levels in air. Test atmospheres for all but two compounds were prepared in specially-designed Tedlar bags of approximately 40 L capacity. A small Tedlar bag, approximately 5 L in capacity, was used for the preparation of test atmospheres of vinyl chloride and benzene.

The preparation of static test atmospheres in bags involves a risk of sample loss over time due to adsorption and/or diffusion. While no single bag material is ideal for use with all classes of chemicals, Tedlar, a fluorocarbon polymer, is considered to be generally inert. Furthermore, the transparency of Tedlar is an important advantage, since it allows for visual observation as to whether a liquid sample injected into a bag has been vaporized.

Tedlar bags were fabricated with two stainless steel fittings each, one for the introduction of liquid sample via microliter syringes, and one for the withdrawal of vapor sample to an instrument. Teflon nuts and washers secured the fittings to the bags. A 1/4 inch nut containing a Teflon-faced GC septum was attached to one bag fitting to complete the liquid sample injection port. A Whitey 1/4 inch OD, stainless steel ball valve was connected to the second

bag fitting to complete the vapor sampling port. The valve through which vapor is withdrawn must have an internal diameter at least as large as the internal diameter of the sampling probes on the OVA and HNU instruments, so that the withdrawal of sample vapor by an instrument is not restricted. This is an important point in the case of the HNU, which draws sample via a small fan rather than a pump.

Ultra zero air (<0.1 ppm total hydrocarbons as methane) was used for the preparation of test atmospheres for the great majority of compounds. Zero air (<2 ppm total hydrocarbons) was used for a few compounds. Instrument response due to zero air alone was subtracted from sample readings, and net readings are reported on the data sheets.

Tedlar bags were completely evacuated before being filled with a known volume of air. Capillary steel tubing was connected to the outlet of the air cylinder's pressure regulator in order that stable flow rates in the vicinity of 5 L/minute could be achieved by adjusting second-stage regulator pressure to a fixed setting in the range of 40 to 60 psi. The flow rate of air was measured frequently between bag fillings using a Matheson Mass Flowmeter. The calibration of the Mass Flowmeter was checked versus a 4 L capacity soap-bubble flowmeter on three occasions. In each case the Mass Flowmeter was found to be reading high by 4 to 6 %. A correction factor of 4.4 or 5 % was applied to Masss Flowmeter readings, and the time required to fill a bag with a desired volume of air was calculated using the most recently obtained corrected flow rate value. Bag filling times were in the range of 4 to 8 minutes, and filling was timed to the nearest second.

Samples used for the preparation of test atmospheres were supplied, in most cases, by the EETD. These samples were of various grades and purities. The actual sample used for each calibration is specified on the data sheets. The liquid density value used in the equation for determining nominal vapor concentrations for individual compounds is also reported on the data sheets.

Syringes of 1, 5, 10, 25 and 100 microliter capacity were used for injecting liquid sample into filled bags. For each test atmosphere concentration, the syringe employed was the one which would deliver the required volume of liquid

with maximum accuracy. Following injection of the sample, bag contents were mixed until all of the injected liquid had vaporized. The required mixing time was typically less than one minute. For several high-boiling compounds, e.g. 1,2-dichlorobenzene, a heat gun was used in order to vaporize the sample from the inner surface of the bag. The time interval between injection of the liquid sample into a bag and instrument sampling of the vapor sample probably did not exceed 5 minutes for any test atmosphere.

By minimizing the time required for 1) vaporization of the injected liquid, and 2) instrument sampling of the prepared vapor concentration, the risk of possible adsorption losses over time is minimized. Nominal vapor concentrations can therefore be assumed to be very close to the actual concentrations sampled. For most compounds studied, test atmospheres were sampled by four HNU's and three OVA's within a span of 10 minutes, and total elapsed time from sample injection was very often less than 15 minutes.

For compounds which gave a response on both the HNU and OVA, the HNUs always sampled test atmospheres first. When sampling with all HNUs and OVAs was completed, the vapor sample was reanalyzed with the HNU which provided the initial reading. The order of sampling for individual instruments never varied. An indication as to whether a significant concentration change occured over the time required for sampling is given by comparing the initial and final readings of the sampling sequence. These readings, and the elapsed time for the complete sampling sequence, are reported on the HNU data sheets in Appendix B.

For high-boiling compounds such as 1,2-dichlorobenzene and 2-ethyl hexanol, it was necessary to sample test atmospheres for several minutes with each instrument before an equilibrium vapor concentration along the sample path to the detector was established and instrument response reached a maximum. Even when the time required for completion of the sampling sequence was 30 to 40 minutes we saw no evidence of significant adsorption losses.

Phenol was the only compound for which static test atmospheres in Tedlar bags could not be analyzed successfully. Phenol at a known concentration in water was successfully vaporized with the heat gun, but HNU and OVA response for

this compound was very slow, while adsorption losses were very high at nominal concentrations between 5 and 30 ppm.

When a sampling sequence was completed, bag contents were evacuated to a fume hood and the bag was cleaned by cycling lab air in and out of the bag several times. Bags were sealed inside a specially designed container connected to a high-capacity pump during this operation, so that filling and flushing could be accomplished by the pressure or vacuum created inside the container. In this way, possible contamination from the pump does not enter the bag, while vapor from the bag does not contaminate the pump. Bag exhaust was vented to the fume hood via tubing connected to a valve on the cycling apparatus. The cleaned bag was used in preparing a vapor sample of higher concentration than the previous sample which the bag had contained.

The only instance where a high concentration was followed by a low concentration was in the case of the first sample concentration in each calibration sequence. The bag used for this initial concentration would have previously contained the highest concentration of the substance studied on the previous day. For this reason, the "bag blank" was always checked before the first calibration sample of each day was prepared. Bags showing carryover of more than a few tenths of a ppm were subjected to further cleaning cycles before use.

Nominal vapor sample concentrations were calculated using a simple equation:

$$C = \frac{24.45 \times I \times D \times 10^3}{MW \times V} \qquad \text{(eq. 1)}$$

where C = vapor concentration in ppm
I = uL of sample injected into the bag
D = liquid density at room temperature
MW = molecular weight of the compound
V = sample volume in liters
24.45 = molar volume of air at 25°C, 760 mm Hg pressure

This equation reduces to three variables plus a constant, K, which is unique for each substance:

$$C = K\ I/V \qquad \text{(eq. 2)}$$

When preparing test atmospheres in Tedlar bags, the desired concentration is known, an appropriate injection volume for that concentration is selected, and equation 2 is solved for the required volume of air. This calculated volume refers to conditions of 25°C and 760 mm Hg pressure. To calculate the time required to fill the bag to the exact volume which will give the desired concentration, the measured flow rate must first be calculated for the same conditions.

Example

K = 200.3 for ethylbenzene

for a 1.0uL injection to give a 5.0 ppm test sample

V = 200.3 x 1.0/5.0

= 40.1 L at 25°C, 760 mm Hg

measured flow rate = 5.20 SLM (Mass Flowmeter, factory-calibrated to read for 20°C, 760 mm Hg)

flow rate, corrected for Mass Flowmeter calibration error (approximately 5% at 5.2 SLM) and calculated for 25C, 760mm Hg.

$$= \frac{5.2 \times 298\ K}{1.05 \times 293\ K}$$

= 5.04 L/min

Time to fill bag = 40.1/5.04 = 7.96 min = 7 minutes and 57 seconds

Calculated test vapor concentrations are subject to three main sources of random error. These are: 1) flow rate error during bag filling, 2) liquid sample injection volume error, and 3) undetected leaks which may develop in a bag after some period of use. One source of systematic error which may have been significant in a few cases was a relatively low purity specification for the test sample (e.g. Practical or Technical grade)

Flow rates were at least known to a high level of precision. The difference between successive flow rate measurements during the course of the calibration work significantly exceeded 2 % on only one occasion. On that occasion the difference was 5 %. Syringe delivery volumes are estimated to have been accurate within perhaps 3 %. The error associated with small leaks would itself be small but cannot be quantitatively estimated. In a few cases we did detect bag leaks. If a leak could not be patched, the bag was discarded, at least until a more permanent repair could be made. Overall, nominal test vapor concentrations could be conservatively estimated to have been within 10 % of actual, unknown, concentration values.

The reader will notice that nominal test sample concentrations reported in the data sheets for all but four compounds are not whole numbers, as would be expected since nominal concentrations are selected. The reason for this is that, early in the course of the experimental work, a value of 22.45 for the molar volume of air at 25°C, 760 mm Hg slipped into our calculations, and this erroneous value was used consistently thereafter. The correct value is of course 24.45. This error was caught only during the final interpretation of data. Therefore, what we thought was a nominal concentration of 10 ppm, for example, turns out to be a nominal concentration of 10.9 ppm when corrected for the original error in the calculation.

Finally, test samples of benzene and vinyl chloride were prepared differently from those of all other compound. As indicated on the respective OVA data sheets in Appendix A, test samples for these compounds were prepared by dilution of higher, accurately known vapor concentrations, or by blending known vapor concentrations in a known volume ratio.

The small HNU regulator used on HNU span gas canisters proved to be quite useful for preparing accurate dilutions of 1000 ppm vinyl chloride (and later for methane sample dilutions). A short length of thick-walled 1/4 inch OD Teflon tubing provided a tight friction fit over the regulator stem which normally extends into the span gas canister. A 1/4 inch Swagelok nut on the end of this tubing allowed for connection to both the vinyl chloride canister outlet and the outlet of the air cylinder regulator. The HNU regulator was

found to have a critical orifice, such that at all pressures greater than approximately 80 psi, a constant flow rate of close to 435 standard cubic centimeters per minute was obtained. Therefore, 1000 ppm vinyl chloride volumes ranging from 125 mL to 2.50 L could be accurately delivered to a Tedlar bag. For benzene, using the 5 L capacity Tedlar bag, various desired concentrations could be conveniently prepared using two pressurized gases (x ppm and y ppm benzene or benzene/air), the HNU regulator, and a stopwatch.

2.1.2 Primary Calibration of Instruments

Methane and benzene are the primary calibrant substances for the OVA and HNU respectively. Three cylinders of benzene in air and one cylinder of methane in air were purchased from Matheson during the course of the present contract, while three other cylinders of methane in air (Linde) were returned to the EETD by the previous contractor. Stated concentration values, grade, and date of preparation are listed below for each of the cylinders.

Benzene			Methane		
PPM	Grade	Date	PPM	Grade	Date
9.99 ± 0.1	Certified	Oct.'83	5	unknown	Aug.'81
101 ± 1	Certified	Oct.'83	11	unknown	Aug.'81
508 ± 5	Certified	Oct.'83	102	unknown	Aug.'81
			498 ± 5	Primary Std.	Oct.'83

2.1.2.1 HNU PI 101

Manufacturer's literature for the HNU PI 101 states that response for benzene is linear up to approximately 600 ppm. Sampling from the three benzene cylinders, we found that all instruments responded similarly, but non-linearly. The ratio of instrument response to benzene concentration decreased significantly as the benzene concentration increased over the range of 10 to 500 ppm. For example, with one instrument (serial no. 82756) set at a response of 101 for the 101 ppm benzene standard, response for the 10 ppm standard was 11.8 while response for the 508 ppm standard was 370.

Since this type of non-linear response was so unexpected, we contacted the manufacturer on three occasions. Various personnel within the company expressed puzzlement, but could offer no explanations, nor could they suggest any adjustments or checks which we had not already conducted. The manufacturer's Service Manager agreed that we were following a proper calibration check procedure.

Having ruled out any possibility of instrument or lamp malfunction, the last remaining possibility was that the stated concentrations for the benzene standard cylinders were incorrect. Since the benzene standards were all new, this was considered an extremely slim possibility. Nevertheless, we did investigate this possibility. A nominal 480 ppm sample of benzene in ultra zero air was prepared by injecting 5.0 microliters of benzene into 2.6 liters of air contained in a 5 L Tedlar bag. Response for this sample on four HNU units was, as expected, only slightly lower than the response obtained with the 508 ppm benzene cylinder standard.

As a second test, a 101 ppm sample of benzene was prepared by diluting 500 mL of 508 ppm cylinder standard with 2.0 L of ultra zero air in the 5 L Tedlar bag. Instrument response for this sample was exactly the same as the response for the 101 ppm cylinder standard. We were thus satisfied that the non-linearity of HNU response was due to the instrument itself rather than to improperly prepared cylinder standards.

At this point, prior to the beginning of the secondary calibration experiments, a decision had to be made as to what response should be selected for the various benzene standards. A compromise was decided upon. Instruments were set to read 96 for the 101 ppm standard. Thus set, response for the 10 ppm and 508 ppm standards were typically 10 % higher and 30 % lower than their respective actual concentrations.

The first compound studied in the course of the secondary calibration experiments was benzene. As seen from the data sheet in Appendix B and the accompanying plots of response versus concentration, HNU response for benzene over the range of 0 to 500 ppm is a smooth curve. The implications of this

fact with respect to the determination of relative response factors will be discussed in a later section.

In terms of field calibration of the HNU, the manufacturer supplies canisters of span gas and a small regulator, described earlier. By adjusting instrument response to the value specified on the span gas canister label, the instrument, it is claimed, will be accurately calibrated for benzene. All span gas canisters available to us were labelled for a reading of 49 at a span potentiometer setting of 9.8. However, we found that when HNUs were set to read 96 for 101 ppm benzene, span gas readings of 59 or 60 were obtained on four instruments. Had the instruments been set to read accurately for the 101 ppm benzene standards, the span gas readings would have been proportionately higher. Although the span gas canister concept is ideal for field calibration purposes, we would not recommend that instruments be adjusted to the labelled response values.

Another important point concerning span gas calibration relates to the flow rate of span gas through the HNU regulator versus the draw rate of the HNU fan. It is difficult to measure the flow rate of air drawn by the HNU. The unit is designed such that a flowmeter cannot be connected to the probe exhaust. Furthermore, because the HNU draws sample via a small fan rather than a pump, any significant restriction at the probe inlet will affect the flow rate.

A Mass Flowmeter connected to the probe inlet represents a significant pressure drop across the HNU fan. While the manufacturer's manual claims a flow rate of approximately 0.5 liters per minute, Mass Flowmeter readings of approximately 100 mL/minute were obtained. Therefore, we attempted to measure the HNU flow rate indirectly. The HNU 1/4 inch OD probe extension was connected to a Swagelok 1/4 inch Tee fitting. The straight branch of the Tee was connected to a cylinder of air while the side branch was connected to a Mass Flowmeter. With air flowing and the instrument on, the flow rate of air was increased until a small flow rate of air in excess of the HNU capacity was registered on the flowmeter. The HNU flow rate was the measured air flow rate minus the excess flow rate measured on the flowmeter.

The results of two such tests gave HNU flow rates of 545 and 580 mL/minute, in accordance with the manufacturer's specification. What is significant is that this flow rate exceeds the flow rate of span gas through the HNU regulator, which was measured as 435 and 455 mL/minute on two separate occasions. Therefore, if the span gas is connected to the HNU probe via a Tee, as suggested in the instrument manual, it will be diluted with air drawn into the sample path through the open branch of the Tee. This will result in a falsely low reading for the span gas. Therefore, the outlet of the HNU regulator should be connected directly to the probe when span gas is used for instrument calibration. Although the span gas flow rate will be less than the capacity of the instrument, the photoionization detector is concentration-sensitive rather than mass-sensitive, and so the reading obtained will not be affected by differences in flow rate.

2.1.2.2 OVA 128

Having satisfied ourselves with respect to the accuracy of the benzene cylinder concentrations, we proceeded to conduct the secondary calibration experiments with EETD priority chemicals, assuming that methane cylinder concentrations were similarly correct. Following completion of all secondary calibrations it was decided that methane standard concentrations should be verified. At this point it was discovered that the methane cylinders from August 1981 all contained concentrations which were lower than the stated concentrations.

This investigation of methane standard concentrations was carried out be comparing one cylinder against another by means of dilution with air. Using the HNU regulator and the 5 L capacity Tedlar bag, as we had done earlier for benzene and vinyl chloride, various dilutions of standard cylinder contents were accurately prepared and analyzed on three OVAs.

Before comparing cylinders against each other, it was first necessary to confirm that OVA response was linear to methane concentration. This was done by preparing three dilutions from the nominal 102 ppm methane cylinder. These results appear in Table 1 below.

Table 1

Linearity of OVA Response to Methane

Nominal ppm	OVA Serial Number		
	9507	9509	9513
0	0	0	0
30	28	29.5	26.5
60	55	57.5	54
90	82	86.5	80.5
102	94.5	99.5	93.5
Intercept	0.08	0.01	-0.45
Slope	0.919	0.968	0.910
Correlation Coefficient	0.9999	0.9999	0.9998

Having established OVA linearity to methane, as well as our ability to prepare accurate dilutions, we proceeded to compare results for dilutions from cylinger X versus cylinder Y, or a dilution from cylinder Y. These comparisons were carried out on two separate dates in order to be certain of the results. Excellent agreement between the two sets of results was obtained. The results from all three OVAs were also in excellent agreement with each other.

The results of this investigation were that the nominal 102 ppm cylinder was reading low relative to the 498 ppm cylinder, and that the nominal 5 ppm and 11 ppm cylinders, while reading in the same ratio as their nominal concentrations, were both reading low relative to the 102 ppm cylinder.

In order to calculate the actual concentrations for each cylinder from the comparative results, we must assume that one of the standards was accurate. We have assumed the 498 ppm methane cylinder to be accurate since it was prepared to Matheson's highest standards, plus the fact that this standard had been recently prepared whereas the three others were more than two years old. Based on this, the actual methane concentrations for the nominal 5, 11, and 102 ppm cylinders were calculated to be 3.8, 8.4, and 93 ppm respectively. These

From HNU data for vinyl chloride, MEK, MIBK, isopropanol and hexane we observed that instrument response change is not exactly linear with respect to a change in the span potentiometer setting. This was most apparent from data for isopropanol and hexane where span settings of 9.8 and 2.0 were employed. Therefore, we would not consider it valid to assume that a desired response at one span setting can be calculated from the measured response obtained at a second span setting.

The actual technique for sampling primary standards from cylinders was slightly different for the OVAs compared to the HNUs. For both types of instrument, the sampling probe was connected to a gas cylinder via stainless steel tubing which incorporated a 1/4 inch Tee fitting, with the open branch of the Tee at right angles to the flow path. In case of the HNU, a constant reading was obtained at all flow rates in excess of the HNU capacity to draw sample. Therefore, it was only necessary to adjust the flow rate of benzene standards to the point where a maximum reading was obtained on the HNU.

For the OVA, which has a mass-sensitive detector, changes in flow rate affect the response. Therefore, when sampling methane from cylinders, it was necessary to ensure that the flow rate supplied to the instrument matched the capacity of each OVA's pump. This was accomplished by connecting the side branch of the Tee fitting to a Mass Flowmeter. While sampling cylinder contents with each OVA, the flow rate of methane was adjusted via the pressure regulator to the point where a slight excess flow of, typically 20 to 60 mL/minute, was registered on the Mass Flowmeter.

The response obtained by sampling directly from the cylinder should equal the response obtained by sampling cylinder contents from a Tedlar bag. Bag versus cylinder readings were obtained with three OVAs for samples from all four methane cylinders. Comparitive readings agreed within 1 % for two OVAs while the third OVA, serial no. 9507, consistently gave a 2 % higher reading for the cylinder sample. This finding was consistent with our suspicion that a small internal air leak was present in OVA 9507. The effect of an internal air leak on instrument response will depend on the pressure drop across the pump. A pressure drop exists when sample is pulled from a bag but not when a flow rate equal to the pump capacity is supplied from a cylinder. In order that methane

latter concentration values appear in all OVA data sheets and are reflected in the calculated OVA relative response factors (RRF) for EETD priority compounds.

2.1.2.3 Daily Monitoring of Primary Calibration

Primary calibrant standards were run on each date that a secondary calibration was conducted. Primary calibrant responses are reported on each of the OVA and HNU data sheets in the Appendices, but these data sheets do not indicate at which point in the calibration sequence each reported response was obtained. Often, two responses are reported for an individual methane or benzene standard, but these readings may have been taken hours apart.

Following any necessary zero adjustment of the OVAs and HNUs, a reading for at least one primary calibrant standard was usually taken prior to the preparation of the first test sample concentration on any date. For the HNUs, the 101 ppm benzene standard was often run prior to the first test sample concentration. If a reading close to the desired value of 96 was not obtained, the instrument's internal calibration screw was adjusted and the standard was run again. The 10 ppm benzene standard was then checked at this point, and/or at the point in the calibration sequence where test sample concentrations gave a response close to 10. The 101 ppm benzene standard was checked at the point where sample readings of close to 100 were obtained, while the 508 ppm standard was run immediately before or after the analysis of the highest test sample concentration on each date. The same strategy was followed for OVA primary calibration checks.

Primary calibration checks were also conducted when test sample responses suggested that response characteristics for any particular instrument may have changed significantly since the time of the previous check. Numerous cases of this phenomenon were observed, most frequently involving HNU units. All primary standard and test sample data for the OVAs were obtained at a span potentiometer setting of 3.0. Span settings for HNU units were as indicated on the data sheets.

standards and bag-contained test sample responses could be compared on an equal basis for OVA 9507, corrected readings equal to 98 % of actual methane standard readings have been reported on the data sheets.

2.1.3 Observations on Instrument Performance

After reviewing the secondary calibration data reported by the previous contractor, which suggested undiagnosed maintenance problems with both OVAs and HNUs, it was decided that secondary calibrations carried out during the present contract period should be conducted using only the four new OVAs and five new HNUs purchased by the EETD. Performance and non-performance characteristics of the instruments in both general and specific terms are discussed below.

2.1.3.1 OVA 128

Assuming that we had first access to the four new OVAs, the initial observations reported below suggest very sloppy quality control on the part of the manufacturer.

Serial No.	Observations
9507	- Hydrogen tanks supposed to be empty, found to contain 1000 psi. - Close-area sampling probe plugged due to improper frit installation. Probe tubing not sealed where it attaches to second component part.
9509	- Short circuit in battery charger. - Damaged threads on main body sampling line fitting.
9513	- No defects

9431 - Battery was not disconnected
- Would not hold hydrogen at high pressure. Enormous leak at threads connecting two components of high pressure regulator.

Since OVA 9431 was obviously unfit for use, our secondary calibration experiments were conducted using the three remaining OVAs.

Based on both the primary and secondary calibration data generated with these instruments, there is some doubt in our minds as to whether OVA response is linear at all readings over the range of 0 to 1000. While OVA response for test sample concentrations was invariably linear on Range X10 (0 to 100), increasingly enhanced, non-linear response was often observed when test sample readings above roughly 200 were obtained on Range X100. This phenomenom was observed on all three OVAs but appeared most pronounced for OVA 9513. Response for the 498 ppm methane standard was also noticeably higher on this particular instrument relative to the response expected on the basis of the 93 ppm methane reading. It would seem unlikely that enhanced response at high concentrations could be due to improper electronic balancing of the amplifier from Range X10 to Range X100. Range to Range balance for OVA 9513 was found to be completely accurate on one particular date where enhanced response at high concentrations was being obtained. Analysis of methane concentrations between 100 and 1000 ppm, prepared from a lecture bottle sample of methane, should prove whether or not OVA amplifiers become non-linear at higher concentrations.

With all OVAs, we found that the 93 ppm methane standard generally gave a lower reading on Range X100 compared to Range X10.

The relative response factors calculated for EETD priority compounds and reported on the data sheets reveal instrument to instrument variations which were somewhat larger than expected. In almost all cases, relative response was highest for OVA 9509 and lowest for OVA 9507. We are not sure what factors are responsible for the observed variations in relative response. Perhaps minute differences in detector geometry are the cause. Another possible cause could be differences in the air to hydrogen ratio at the detector. It may only be

coincidence, but the order of air sampling rates for the three OVAs, from highest to lowest, agrees with the general order of relative responses obtained for the priority chemicals studied.

Although we can't be certain that there was a cause and effect relationship, we observed higher methane standard readings on Mondays when the laboratory was cold due to weekend shutdown of the heating system. The possibility of a significant dependence of OVA response on temperature should be investigated, since this would have obvious implications with respect to field use of the instrument.

During the course of the calibration experiments, the only maintenance problems encountered with the OVAs were related to the hydrogen supply systems. Significant, though not dangerous, leaks developed around the hydrogen tank and/or refill valves of OVAs 9509 and 9513 within days of initial use. This was in spite of efforts to be gentle with the valves. These leaks were eliminated by simply tightening a compression fitting inside the main body of the instrument, but leaks later reappeared in both of these units.

The most serious problem was a suspected blockage in or near the low pressure hydrogen regulator of OVA 9509. Suddenly, one morning, zero pressure registered on the hydrogen supply pressure gauge. Whether because of, or in spite of efforts to remove the blockage over a period of two days, the problem was alleviated to the point where the instrument could be used again. However, from this point onward it took as long as 30 minutes after opening the hydrogen supply valve before hydrogen pressure reached a maximum value.

2.1.3.2 HNU PI 101

Only three of the five new HNUs were suitable for use in the calibration studies.

When first checked, HNU serial no. 82755 was found to have a dead battery which could not be recharged. A new battery was installed and charged, but neither the source lamp nor the fan would operate. No investigations or

repairs were attempted beyond this point.

When first checked, HNU serial number 82758 operated similarly to the other HNUs, giving a response in the mid-seventies for the 101 ppm benzene standard. However, when it was decided to set a response of 96 for this standard, the maximum reading which could be obtained on this unit was only 86. This instrument was loaned out to a representative for the Canadian distributor of the HNU, who wanted to investigate the unexpected non-linear response described earlier. When the unit was returned, the maximum reading which could be obtained for 101 ppm benzene was down to 73. It would appear that this HNU contained a very weak source lamp. We can only speculate as to why a dying lamp should be found in a new instrument.

Lamp problems were also experienced with HNU serial no. 82756. After approximately two weeks of intermittent use, low and fluctuating response was obtained for the 101 ppm benzene standard. The source lamp was removed and had a darkened appearance. The only new replacement lamp which was available was inserted into this unit and resulted in a reading of 122 for the 101 ppm benzene standard, compared to the reading of approximately 66 obtained with the old lamp.

Since only three of the new HNUs were working to a satisfactory level, one of the HNU units used by the previous contractor (serial no. 81470) was also used for our calibration studies. This unit was selected because it appeared to be in better shape than three other units used previously. In fact, this unit proved to be the most trouble-free of the four HNUs used for our calibration work.

Each of the four HNUs employed for priority chemical calibrations exhibited their own quirks. Serial numbers and typically observed phenomena are listed below.

Serial Number	Typical Phenomena
82764	- Prone to short-term response changes of 10 % or more.

81470 - By far the slowest response for high-boiling compounds.

82756 - Occasional large changes in response due to electronic causes. Always solved by tightening screws on probe end-cap.

82757 - Often small fluctuations (± 0.5 scale div.) in readings.
- Reads zero in STANDBY, but zero always offset by 0.5 scale divisions on 0 to 200 and 0 to 2000 ranges. Equivalent to readings of 1 and 10 on these ranges. Always subtracted from sample readings.
- Most difficult unit to calibrate. Reading appears stable over short-term but often increases very slowly to maximum stable reading.

Generally, after taking into account the response values obtained for benzene on each unit, HNU secondary calibration results indicated a fairly low degree of instrument to instrument variability. This is in contrast to OVA data, where larger than expected variability was indicated. Variability among instruments was not consistent from one compound to the next. In some cases, responses for three instruments were close, while response for the fourth unit was significantly higher (e.g. 82757, isopropanol). However, there were many cases where all four HNUs agreed very well with each other (e.g. benzene, m-xylene, n-butyraldehyde). While it is difficult to calculate variability when instrument responses are non-linear, we would estimate that in many cases the difference in response between thee highest and lowest reading HNUs was 10 % or less. Relative response varied by less than 3 % between highest and lowest when span gas was analyzed with the four HNUs.

Readings obtained for a sample or standard at two range settings always agreed very closely in the case of all HNUs. Readings obtained at the higher of two range settings always agreed within ± 0.5 scale divisions (100 divisions full-scale) of the reading obtained at the more precise range setting. In this

respect the HNUs are superior to the OVAs, which must be electronically balanced from range to range by the operator.

During the course of the secondary calibration study there were numerous instances where response from a particular HNU increased or decreased by roughly 10 % over a period of a few hours or less. Such changes were monitored by frequent checks of primary calibrant response, often prompted by apparent changes in the response of an individual unit to different test sample concentrations. Observed changes in response could be due to power supply or amplifier output changes (sudden or gradual), physical phenomena such as fouling of the light source window, or some combination of these factors. It is suspected that no single cause was responsible for all observed cases of response change.

Fouling of the light source window was not expected to be a problem in the lab environment with clean samples. However, it is possible that fine particulate matter contained in samples did adhere to the light source window. Light source windows on all HNUs were cleaned at the same time on two or three occasions during the course of the calibration studies. Even though sample history was identical for all units, the change in instrument response due to source window cleaning was unpredictable. In some cases significantly higher response was obtained while in other cases there was a negligible effect.

No serious maintenance problems were experienced with the HNUs, other than the problem of weak source lamps. Lamp replacement is accomplished very easily.

2.1.4 Discussion of OVA Calibration Data

Secondary calibration data and response factors relative to methane (RRF) are reported in Appendix A for 32 EETD priority organic substances. Perhaps 20 additional priority list organics would be amenable to OVA analysis.

By definition, the calculation of RRFs for each of the priority chemicals compensates for the fact that primary calibrant responses were often significantly greater than the actual methane concentrations sampled. Relative response was calculated by performing linear regression analysis on both the

sample and standard data. The RRF is equal to the sample line slope divided by the standard line slope.

One must be cautious when assessing the results for linear regression analysis. Consider the case where OVA response exactly equals sample concentration at levels of 0, 20, 40, 60, 80 and 100 ppm, while a response of 800 is obtained for a 1000 ppm sample. Linear regression analysis of this data yields a line with a slope and correlation coefficient of 0.79 and 0.9997 respectively. Obviously, the slope of this regression line was determined almost entirely by one data point (1000,800). A more realistic measure of the true relationship between concentration and response is obtained in this case by rejecting the last data point and considering only the remaining 6 points.

The hypothetical case above illustrates that one must not assume that a high correlation coefficient necessarily means that the slope of the regression line accurately reflects the relationship between the dependent and independent variables.

In the case of the OVA data, we must be cautious in the selection of data points for least squares analysis because of the increasing intervals between test sample concentration values. As was the case with the hypothetical data, the slope of the linear regression line for actual OVA data would be highly biased towards the response values obtained for the highest concentration test samples.

As discussed previously, and as evident on the data sheets,, OVA response at high concentration levels was obviously non-linear in a great many cases. By contrast, responses obtained on Range X10 (0-100) were very linear in all cases. Therefore, in order to obtain a regression slope unbiased by the non-linear responses obtained at high test sample concentrations, we have generally omitted OVA data obtained on Range X100 from linear regression analysis. This is not to say that the omitted data is bad data, resulting from inaccurately prepared test samples. Indeed, these data are considered to accurately reflect OVA performance. In most cases, in fact, inclusion of all sample and standard data points in the regression analysis would not have significantly altered the value of the RRF reported. All data points are shown

on the regression plots accompanying the data sheets.

The data reported in Appendix A are generally much higher than the data reported in the previous contractor's reports. This was expected. Compared to relative response factors reported by the OVA manufacturer, our values are most frequently lower, but in reasonably close agreement. However, the manufacturer states that RRFs must be determined for each individual instrument. Given the magnitude of variability in RRFs obtained with three OVAs in this study, we would be inclined to agree with the manufacturer on this point.

The EETD now has possession of 9 OVAs, several of which are in various states of disrepair. Clearly, all instruments cannot be calibrated for all substances within a reasonable time frame. This should not be necessary. Rather, it is suggested that secondary calibrations for perhaps five selected compounds be carried out using all OVAs. This short study would accomplish three things. First, by selecting one or several chemicals for which calibrations have already been carried out, the results of the initial calibration can be verified. Second, data from 9 instruments will provide an accurate measure of typical OVA to OVA variability. It should then be possible to calculate the typical average response of an OVA to each substance previously calibrated, based on the calibration data in hand plus the known typical variation between instruments.

Experimental and manufacturer's relative response factors for 21 chemicals are listed for comparison purposes in Table 2. Differences between our experimental response factors and the manufacturer's values appear to be more significant for chloroform, carbon tetrachloride, ethyl benzene, and most alarmingly, o-dichlorobenzene. Perhaps chloroform and ethyl benzene should be two of the chemicals selected for recalibrations when all OVAs are serviceable. The ethyl benzene and cumene used for calibration purposes were analyzed by gas chromatography. Chromatograms for both substances showed two peaks of roughly equal area. This was highly unexpected since both samples came from sealed vials sold for use as GC calibration standards.

We cannot explain the startling RRF discrepancy for 1,2-dichlorobenzene. Being unable to find anything wrong with our liquid sample (Reagent grade), test sample preparation techniques (used a heat gun to vaporize liquid), or OVA analysis (sampled for 3 minutes to reach equilibrium response), we are inclined to conclude that the discrepancy is due to errors in the manufacturer's calibration data for this substance.

A significant amount of work remains to be done before the OVA can be considered field-ready for Level 2 spill response use. Suggestions concerning appropriate areas for further development are found in the Recommendations.

Table 2

Experimental and Manufacturer's Relative Response Factors

	RRF			
	Manufact.	9507	9509	9513
Styrene	0.85	0.93	1.06	0.99
Benzene	1.50	1.45	1.64	1.43
Toluene	1.10	1.08	1.30	1.17
Ethyl benzene	1.00	1.27	1.47	1.35
m-Xylene	1.11	1.09	1.31	1.20
1,2-Dichlorobenzene	0.50	1.64	1.87	1.76
Dichloromethane	1.00	0.85	0.93	0.87
Chloroform	0.65	0.44	0.53	0.46
Carbon tetrachloride	0.10	0.05	0.07	0.06
1,1,1-Trichloroethane	1.05	0.94	1.04	0.97
Tetrachloroethylene	0.70	0.56	0.68	0.59
Methanol	0.12	0.09	0.13	0.10
Ethanol	0.25	0.22	0.26	0.24
Isopropanol	0.65	0.58	0.65	0.60
1-Butanol	0.50	0.40	0.45	0.42
Hexane	0.70	0.72	0.81	0.75
Cyclohexane	0.85	0.69	0.75	0.70
Acetone	0.60	0.45	0.57	0.51
Methyl ethyl ketone	0.80	0.58	0.71	0.65
Methyl isobutyl ketone	0.80	0.64	0.78	0.69
Vinyl acetate	0.50	0.42	0.50	0.45

2.1.5 Discussion of HNU Calibration Data

Calibration data are reported in Appendix B for 27 priority list organics.

Magnitude of instrument to instrument variability, non-linearity of response for benzene, short-term changes in instrument response, and the less than linear relationship between span setting and HNU response have already been discussed.

From the plots accompanying the HNU data sheets it is apparent that response is non-linear for all chemicals, although for any small range of concentration, e.g. 0 to 20 ppm, response will usually be essentially linear. At high concentrations, approaching the saturation level for the UV source, the response curve becomes quite flat and the HNU loses its usefulness as a quantitative tool. At a span setting of 9.8 we never obtained a reading greater than perhaps 500 when the probe extension was inserted into the neck of a bottle and held in the head-space vapour of a pure solvent. Therefore, it is likely that readings obtained during field use of the HNU will be confined to the 0 to 20 and 0 to 200 ranges.

Since HNU data for all compounds including benzene are non-linear, and since the degree of non-linearity will vary with concentration from one substance to the next, HNU secondary calibration data cannot be accurately defined in terms of a relative response to benzene. Response factors calculated from sample and standard readings obtained at a single identical concentration will be valid only for that particular concentration.

Instrument to instrument variability of the HNU appears to be small enough that secondary calibration meter scales for priority list chemicals can be derived directly from the raw data obtained with four instruments. From the raw data one must simply select the typical HNU response for any particular concentration of a specific chemical. The raw data in many cases will require adjustment, on a curve rather than on a line, so that responses on the four units can be compared at equal responses for benzene. This procedure for data interpretation will be somewhat time consuming since it will involve plotting

and interpolating along the response curves obtained for each priority chemical. However, we do not see any viable alternative to this.

In the field it will be necessary to set HNU response for benzene or some surrogate standard to exactly the same value obtained for benzene or the surrogate (e.g. Span Gas) during the laboratory calibration upon which a particular meter scale was based. This may be done either with the internal set screw adjustment or with the span potentiometer. There is a difference between these options.

The advantages of the span adjustment option are ease of adjustment and probably an extended useful service life for each source lamp. If a span setting of 8.0, for example, is necessary in order to get the required benzene (or surrogate) response, then a meter scale based on the secondary calibration data in Appendix B should yield accurate results, even though the original data was obtained at a span setting of 9.8. The disadvantage of the span adjustment option is that we lose the capability of specifying a particular span setting for a particular compound. Specifying a span setting which will allow for sensitive response is an attractive option in the case of compounds, and there are many of them, for which HNU response is inherently low.

The option of specifying the span setting for individual compounds requires that primary calibrant response be adjusted internally. This is somewhat inconnvenient, but not difficult. We see two disadvantages to this option. Recalibration of low responders such as hexane, ethanol, butanol etc. would be required at a span setting much lower than the 9.8 setting used in the present study. The 9.8 span data cannot simply be recalculated to a different span setting because it has been demonstrated that response and span setting are not linearly related. The second disadvantage is that a point will be reached, after some unknown period of use, where adjustment of the internal set screw will no longer be sufficient to achieve the desired standard response with the span setting fixed. At this point the source lamp would have to be replaced.

At the present time we cannot claim a clear preference for either of these options.

With respect to specific calibration data in Appendix B there are only a few points we would like to discuss. As expected, high (and in several cases very similar) data was obtained for the aromatic organics. A claim that the HNU does not respond to styrene because this substance polymerizes in the UV light of the source lamp has clearly been refuted.

Experimental HNU response for the aromatics, plus methyl ethyl ketone and methyl isobutyl ketone, at the 100 ppm level generally agree with the 100 ppm relative response factors published in the HNU manual. Experimental data for carbon disulfide, acetone, vinyl chloride, and hexane appear significantly lower than the 100 ppm responses reported by the manufacturer. Comparative data is not available for other compounds included in our calibration studies, but we would not place any great emphasis on the observed cases where agreement is lacking.

The data sheet for methylene chloride undoubtedly reflects response to sample impurities since the ionization potential for this compound is 11.35 eV, well above the 10.2 eV energy of the HNU source lamp. Surprisingly, turpentine generated the highest HNU response of all substances studied. An average molecular weight of 136 was used in the calculation of test sample vapor concentrations for this substance. The very odd HNU response behaviour for morpholine, described in data sheet footnotes, cannot be explained at this time.

2.2 HACH DR-EL/4 DEVELOPMENT

Since air is the medium of highest priority in terms of immediate potential hazard in a chemical spill situation, the main focus of the work carried out during the present contract period was on development of the OVA and HNU systems. Our basic aims with respect to the development of Level 2 capability for water analysis were to become familiar with all aspects of the Hach DR-EL/4 system and its various test methods, and to assess the potential applications and limitations of this system in terms of Level 2 concepts and criteria for field use.

Familiarity with Hach kit performance was gained by carrying out the test methods for several inorganic species, using test solutions of pure substances in deionized water. These test methods had been evaluated previously, but only at the maximum concentration specified for the respective test ranges. All test methods, except one, involved use of the Hach spectrophotometer for analysis. Results reported here were all obtained with the spectrophotometer operating on DC power.

Analytical results for the various test methods are reported in the following sections. The reader is referred to previous reports on Hach kit development as well as the Hach DR/EL-4 Methods Manual for details on test procedures. Discussion of results is brief. In general, good results were achieved, as would be expected for test samples of pure substances in deionized water. While performing the various test procedures, several observations were made which could be of significance in terms of field use of a particular method. These observations would be most appropriately reported in a Supplementary Hach Kit Field Manual.

2.2.1 Chromate, Sodium Test Results

Table 3·

Test Sample Results - Chromate

ppm Equivalent Na_2CrO_4	Test Results (ppm) Series 1	Series 2
25	25	---
102	90	100
254	245	250
509	490	500
763	740	750
1018	970	1000

Since we were not able to obtain sodium chromate, we used potassium chromate for the preparation of test samples. This test method is colourimetric and

applies over a concentration range of 0 to 1000 ppm. The results reported in Table 3 represent visual interpolations from the non-linear meter scale.

These results indicate that the test method is capable of delivering accurate results over the range of concentrations tested. Chromate levels lower than 25 ppm cannot be accurately determined using this method.

2.2.2 Copper Test Results

Test samples were prepared by serial dilution of a 300 ppm stock solution of reagent grade copper sulfate ($CuSO_4.5H_2O$) in deionized water. This colourimetric Hach method applies over a concentration range of 0 to 3 ppm Copper. Test results are reported below in Table 4.

Table 4

Test Sample Results - Copper

	Test Results (ppm)	
ppm Cu	Initial Reading	Second Reading
0.10	0.07	0.10
0.50	0.42	0.45
1.00	0.94	0.94
1.50	1.41	1.41
3.00	2.85	---

We would not want to draw too much significance from the results above, but the initial readings at the 0.1 and 0.5 ppm levels were, in comparison to actual concentrations, proportionately lower than the readings at the three higher concentrations. The second set of readings was taken approximately 15 minutes after the first set, and within the specified 30 minute time limit for completion of the analysis following the addition of the Cu Ver I reagent. The higher results for the second reading at 0.1 and 0.5 ppm Cu suggests that colour development was not complete at the time of the initial reading. It was noted that the Cu Ver I reagent powder was difficult to dissolve completely.

Nevertheless, we would consider these results to be sufficiently accurate at all test concentrations.

2.2.3 Nitrogen, Nitrate Test Results

Test samples were prepared by serial dilution of 600 ppm stock solutions of nitric acid and ammonium nitrate in deionized water. This colourimetric method applies over a concentration range of 0 to 30 ppm nitrogen as nitrate ion. Test results are given in Table 5. The reagent blank equivalent to 0.5 ppm has been subtracted from test sample concentration readings.

Table 5

Test Sample Results - Nitrogen, Nitrate

	Net Test Results (ppm)	
ppm NO_3	HNO_3	NH_4NO_3
Reagent Blank	0.5	0.5
1.0	0.7	0.6
5.0	3.8	3.6
10.0	8.0	8.7
30.0	24.5	25.5

These low results are consistent with the low results obtained for these two compounds at the 30 ppm level by the previous contractor. It is apparent from these test results that accuracy was proportionately lower at lower concentration levels. Any attempt to explain these low results at the present time would be mere speculation.

2.2.4 Nitrogen, Ammonia Test Results

Test samples were prepared by serial dilution of the same ammonium nitrate stock solution used for the nitrogen, nitrate test solutions, and by dilution of a 1977 ppm solution of $NH_4H_2PO_4$. The Hach method is colourimetric and applies to a concentration range of 0 to 2 ppm nitrogen as ammonia. Test

sample temperature was approximately 22°C. The specified temperature for analysis is 20 ± 1°C. Test results are reported in Table 6.

Table 6

Test Sample Results - Nitrogen, Ammonia

ppm equivalent	Test Results (ppm)	
NH_3	NH_4NO_3	$NH_4H_2PO_4$
0.10	0.10	---
0.25	---	0.22
0.50	0.46	---
0.74	---	0.68
1.48	---	1.42
1.50	1.41	---
2.00	1.85	---

These test results indicate a satisfactory level of accuracy for the Hach method. It may be of significance that nitrogen, ammonia test results were in fairly good agreement with test sample concentrations whereas nitrogen, nitrate test results were quite low for test samples prepared from the same stock solution of ammonium nitrate. This would suggest that the low results obtained for nitrogen, nitrate were due primarily to chemical factors rather than inaccurate sample preparation.

2.2.5 Sulfate Test Results

Test samples were prepared by serial dilutions of 1500 ppm stock solutions of zinc sulfate and aluminum sulfate in deionized water. Sulfate ion is precipitated as barium sulfate and the resulting turbidity is measured using the Hach spectrophotometer over a concentration range of 0 to 150 ppm. Test results are reported in Table 7.

Table 7

Test Sample Results - Sulfate

ppm SO_4	Test Results (ppm) $Al_2(SO_4)_3.18H_2O$	$ZnSO_4.7H_2O$
5	5.5	5.0
25	25	27
50	48	48
150	145	150

The above results indicate that very good accuracy is achievable with the Hach Sulfate method at all concentrations within the specified test range.

2.2.6 Phosphate Test Results

Table 8

Test Sample Results - Phosphate

ppm PO_4	Net Reading (ppm)
Reagent Blank	0.07
0.05	0.08
0.10	0.11
0.50	0.50
1.00	1.03
1.67	1.7
2.0	2.0

Test samples were prepared from the same stock solution of ammonium dihydrogen phosphate used for the preparation of test sample concentrations for the nitrogen, ammonia method. The Hach method for reactive phosphorus is colourimetric and applies over a concentration range of 0 to 2 ppm. Test results are reported in Table 8. The reagent blank, equivalent to 0.07 ppm,

has been subtracted from test sample concentration readings.

This test yielded results of excellent accuracy at all test sample concentrations other than the 0.05 ppm level. We also attempted to analyze samples of $NH_4H_2PO_4$ by the Hach method for total phosphorus. The purpose of this exercise was to see if the results obtained using the total phosphorus method would match the excellent results obtained using the reactive phosphorus method. More importantly, however, we wanted to try out a procedure which called for sample digestion over a flame.

The Heatab Cookit was used for the hot digestion portion of the test procedure. We found that the Heatab Cookit, which was considered to be of potential use in the field, required a new fuel tablet approximately every ten minutes. Furthermore, the rate of sample heating could not be controlled since the height of the flame fell considerably over a short period of time. In fact, the very large flame observed when fuel tablets were first ignited is considered to represent a potentially very hazardous situation in terms of personnel safety, especially if the Heatab Cookit is used within a small, confined area, such as the interior of a van. We would suggest that some alternate method of heating samples in field situations be found.

2.2.7 Total Acidity Test Results

Solutions of hydrochloric acid at three concentration levels were tested using the Hach Total Acidity method. This is a titrimetric method which calls for boiling of the sample for 2 minutes. Again, performing unsatisfactorily in our opinion, the Heatab Cookit was used to heat the samples. Using the Hach Digital Titrator, fairly accurate results of 49, 95, and 237 were achieved for test samples representing concentrations of 50, 100, and 250 ppm equivalent to $CaCO_3$ respectively.

While this was our first experience with the use of the Digital Titrator, we found the hand-held titration to be awkward, largely because effective swirling of the sample during titrant addition was inhibited by our inability to grasp the neck of a hot erlenmeyer flask with bare fingertips. Optimum accuracy for all Hach methods involving titrations, especially where hot

solutions are involved, can be achieved by using a magnetic stirrer and by clamping the Digital Titrator.

We also attempted to determine Free Acidity on a room temperature sample containing 250 ppm equivalent to $CaCO_3$ of HCl. For this sample, of course, Free Acidity and Total Acidity are equal. Compared to a 245 ppm reading for Total Acidity, the Free Acidity reading for this sample was less than 230. An accurate reading was not obtained because the endpoint colour of the titration was difficult to judge and was overshot. We would recommend that buffer solutions of a pH equal to the endpoint pH of a particular method be used as endpoint colour references when Hach titrimetric methods are applied to field samples. This precautionary step should be required at least in those cases where field samples exhibit some colour of their own which can mask the endpoint colour.

2.2.8 Prospective Areas for Future Development

There remains wide scope for development in the area of on-site monitoring of water and soil for spilled hazardous substances at a Level 2 stage of analytical sophistication. The test methods presently available with the Hach DR-EL/4 merely scratch the surface of potential Level 2 capability. Not all presently available Hach methods which could apply to chemicals on the EETD priority chemicals list have been evaluated in the lab. Specifically, methods for zinc, arsenic, sulfite, and potassium have not been experimentally evaluated. The zinc and arsenic methods are not considered to be appropriate for field use by non-technical personnel since they involve hot acid digestion and distillation respectively.

Wherever possible, development of additional test methods should incorporate the use of Hach technology such as the spectrophotometer and the Digital Titrator. At the least, potential Level 2 methods should not be complex, require a high degree of skill to perform safely, or require the use of chemicals of high potential hazard in the hands of non-technical personnel. Quantitative, non-Hach methods for morpholine, hydrogen peroxide, and formaldehyde in water are known. The respective test procedures are compatible with Level 2 criteria and should be adaptable to the use of Hach technology.

The analysis of priority list organics in soil and water, and the analysis of water-soluble priority inorganics in soil represent the major areas for potential Level 2 development. Fewer difficulties are foreseen in the latter development area. If an efficient apparatus and procedure for extracting soil samples with deionized water can be devised, then soil sample extracts can be analyzed by existing Hach methods for water. The development of field methods for the extraction and analysis of organics in water and soil is likely to be a much slower and much more challenging process.

The least severe immediate hazards in a spill situation would generally be associated with water-insoluble inorganics in soil. Conversely, test methods for such chemicals would generally involve hot acid digestion of samples. Based on these and other considerations, it is recommended that soil samples contaminated with water-insoluble priority list inorganics be sent to a home-base laboratory for analysis.

Individual Hach methods apply to widely-varying concentration ranges. Those methods which apply to a small range of concentration, e.g. 0 to 3 ppm, are considered to be of greater potential value in a chemical spill situation. Field samples can always be diluted into the concentration range of a test method (minimizing the effect of natural interferences at the same time), but situations could arise where test samples contain environmentally signiificant levels of contamination which are too low to be measured using a method whose applicable concentration range is large, e.g. 0 to 1000 ppm. Therefore, emphasis should be placed on developing methods which are sensitive to low concentration levels.

The Hach system was designed for use in a temperature-controlled environment (20°C to 27°C) since temperature affects chemical reaction rates. In cool or very hot weather the Hach kit could be used outdoors, directly at the spill site, if provision is made for heating or cooling water samples to the specified temperature range. Hach kit testing must be carried out indoors, or in a warm van, during cold weather spill incidents.

REFERENCES

1. Fingas, M.F., Thornton, D.E., "The Hazardous Material Spill Program of the Environmental Emergency Branch", Spill Technology Newsletter, Vol. 7(2), 1982

2. Lioy, P.J., Lioy,M.J., Air Sampling Instruments for Evaluation of Atmospheric Contaminants, 6th Edition, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio, 1983

APPENDIX A

OVA 128 CALIBRATION DATA FOR PRIORITY LIST SUBSTANCES

ACETONE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 58.1 DENSITY : 0.785 g/ml (25 C)

SAMPLE : J.T. BAKER, REAGENT GRADE DATE : 6 DECEMBER, 1983

METHANE STANDARDS

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	8.70	10.00	8.70	----
Yes	93.00	87.50	105.00	97.00	----
No	498.00	480.00	600.00	585.00	----
	SLOPE=	0.9370	1.1266	1.0433	
	INTERCEPT=	0.3948	0.2558	-0.0304	
	CORRELATION COEFFICIENT=	1.0000	1.0000	1.0000	

SAMPLE

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	1.00	30.30	10.9	6.50	8.60	6.90	---
Yes	1.50	22.70	21.6	11.00	16.00	12.50	---
Yes	5.00	30.30	54.5	24.50	35.00	28.50	---
Yes	8.00	24.30	108.8	50.00	70.50	57.00	---
Yes	25.00	30.30	272.6	115.00	175.00	145.00	---
No	40.00	24.30	543.8	250.00	365.00	315.00	---
No	102.00	30.30	1090.3	540.00	780.00	685.00	---
No	100.00	20.20	1635.4	845.00	1000.00	1000.00	---
	SLOPE=			0.4193	0.6383	0.5294	
	INTERCEPT=			1.7530	1.0016	0.3085	
	CORRELATION COEFFICIENT=			0.9994	0.9999	0.9999	
OVA RELATIVE RESPONSE FACTOR _____				0.4475	0.5666	0.5074	

ACRYLONITRILE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 53.1 DENSITY : 0.80 g/ml (20 C)

SAMPLE : J.T. BAKER, PRACTICAL GRADE DATE : 30 JANUARY, 1984

METHANE STANDARDS

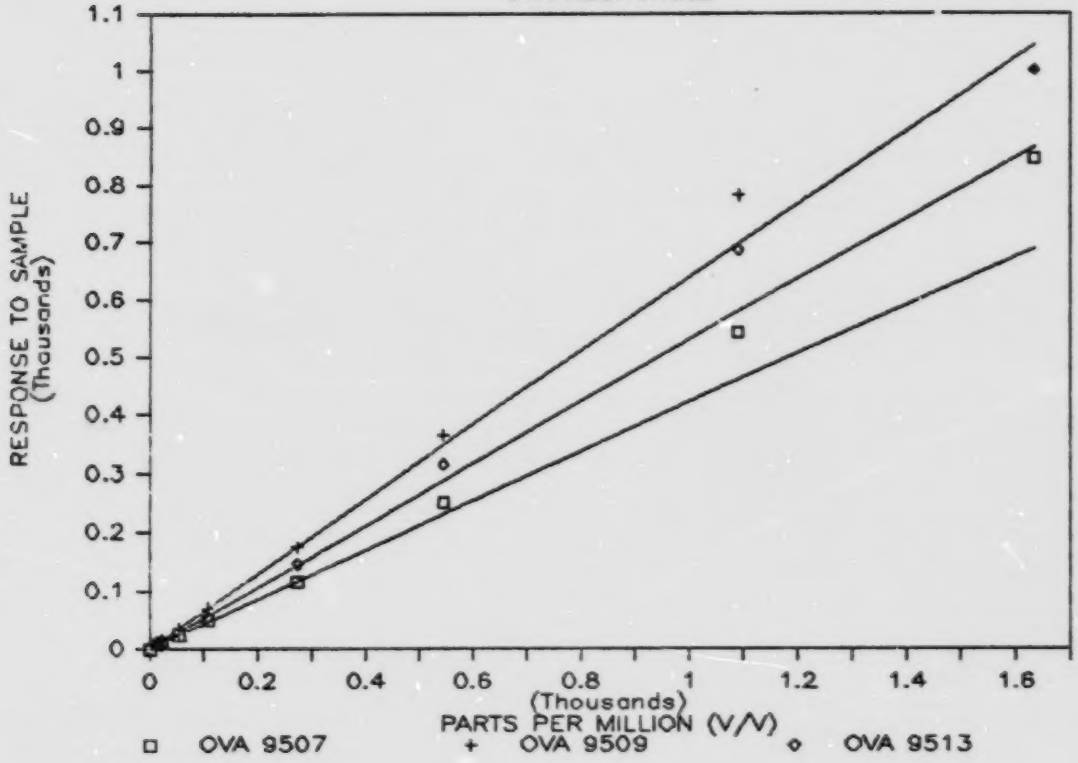
Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	3.60	4.30	4.70	4.20	----
Yes	8.40	9.60	10.10	9.10	----
Yes	93.00	95.50	105.00	100.00	----
No	498.00	495.00	510.00	590.00	----
	SLOPE=	1.0225	1.1256	1.0746	
	INTERCEPT=	0.4593	0.3457	0.0621	
	CORRELATION COEFFICIENT=	1.0000	1.0000	1.0000	

SAMPLE

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	0.30	33.80	3.3	2.40	2.55	2.35	2.40
Yes	0.40	27.10	5.4	3.95	4.25	3.85	3.95
Yes	1.00	33.80	10.9	7.30	7.90	7.00	7.30
Yes	2.00	27.10	27.2	18.00	18.50	18.00	17.50
Yes	5.00	33.80	54.5	35.00	37.50	36.00	34.50
Yes	5.00	22.60	81.5	54.50	59.50	56.00	54.00
Yes	10.00	33.80	109.0	68.50	76.00	71.00	68.50
No	25.00	28.20	326.6	200.00	220.00	240.00	200.00
		SLOPE=		0.6382	0.7046	0.6619	
		INTERCEPT=		0.4323	0.0799	0.1339	
		CORRELATION COEFFICIENT=		0.9993	0.9995	0.9995	
		OVA RELATIVE RESPONSE FACTOR _____		0.6242	0.6259	0.6160	

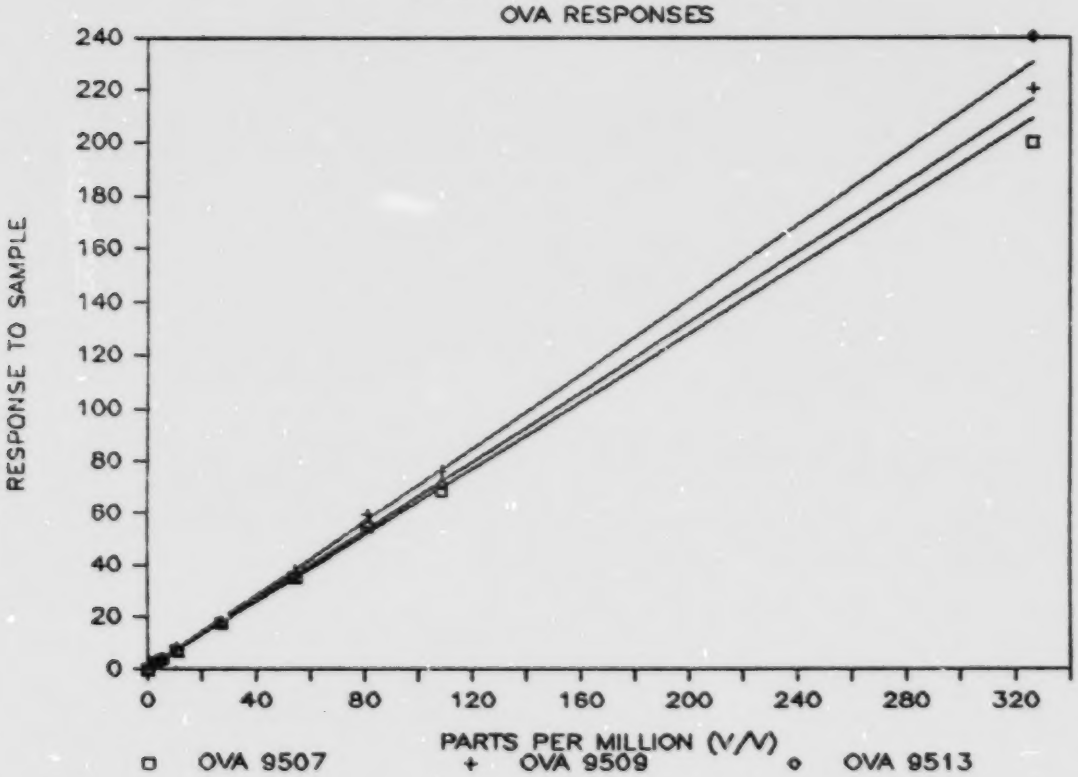
ACETONE

OVA RESPONSES



ACRYLONITRILE

OVA RESPONSES



BENZENE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 78.12 DENSITY : 0.8787 g/ml (20 C)

SAMPLE : MATHESON PREMIX CYLINDERS (ANALYSED) DATE : 24/25 NOVEMBER, 1983

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	93.00	90.00	105.00	96.00	----
Yes	490.00	490.00	583.00	585.00	----
Yes	93.00	88.00	105.00	94.00	----
Yes	490.00	490.00	585.00	570.00	----
Yes	490.00	490.00	610.00	580.00	----
	SLOPE=	0.9872	1.1951	1.1780	
	INTERCEPT=	-1.7374	-3.0076	-9.0144	
	CORRELATION COEFFICIENT=	1.0000	0.9993	0.9997	

SAMPLE
****

LR	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.0	0.00	0.00	0.00	---
Yes	5.0	7.00	9.00	7.20	---
Yes	15.0	20.50	26.50	22.50	---
Yes	39.0	54.00	71.00	60.00	---
Yes	152.0	210.00	260.00	240.00	---
Yes	355.0	510.00	690.00	600.00	---
Yes	50.5	72.00	101.00	79.00	---
Yes	203.0	290.00	420.00	340.00	---
Yes	10.0	14.50	21.00	17.00	---
Yes	101.0	135.00	210.00	170.00	---
No	500.00	785.00	>1000.00	980.00	---
	SLOPE=	1.4321	1.9629	1.6865	
	INTERCEPT=	-1.9583	0.2042	-3.3611	
	CORRELATION COEFFICIENT=	0.9998	0.9989	0.9996	
OVA RELATIVE RESPONSE FACTOR _____		1.4587	1.6424	1.4317	

1-BUTANOL - OVA RELATIVE RESPONSE FACTORS

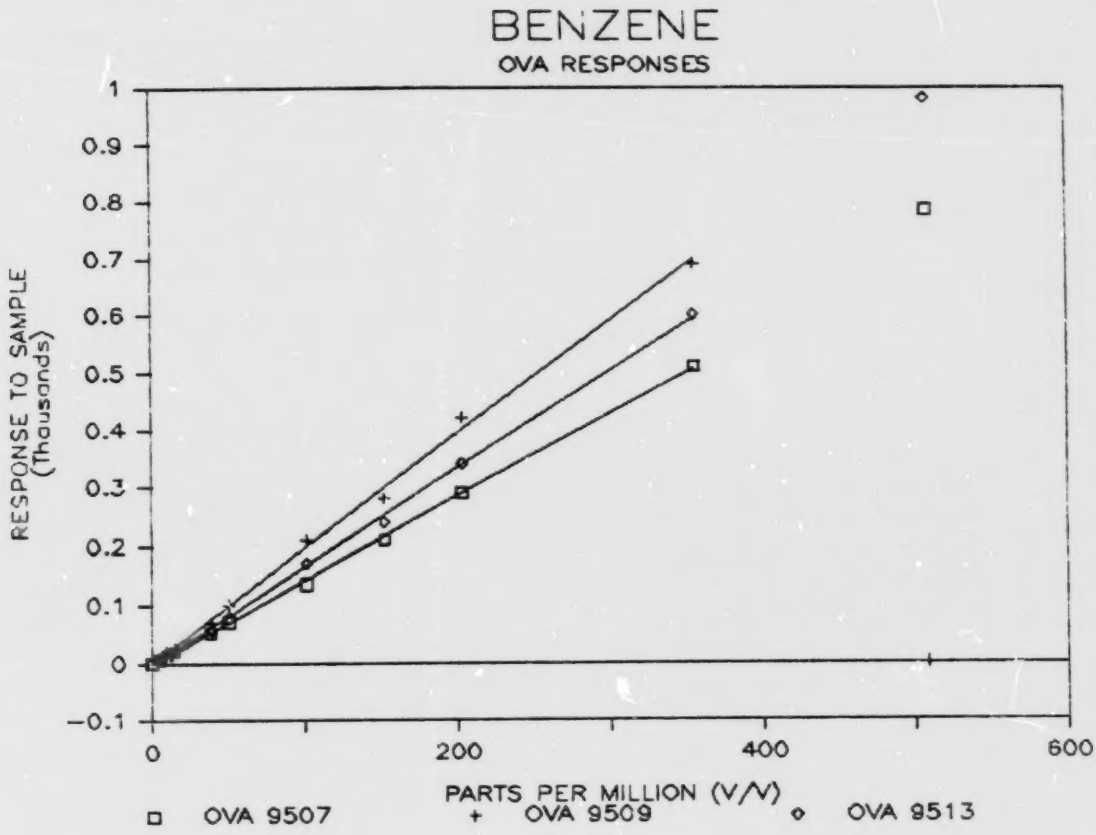
SYNONYMS : n-BUTANOL, n-BUTYL ALCOHOL
MOLECULAR WEIGHT : 74.1 DENSITY : 0.81 g/ml (20 C)
SAMPLE : J.T. BAKER, PHOTREX REAGENT GRADE DATE : 15 DECEMBER, 1983

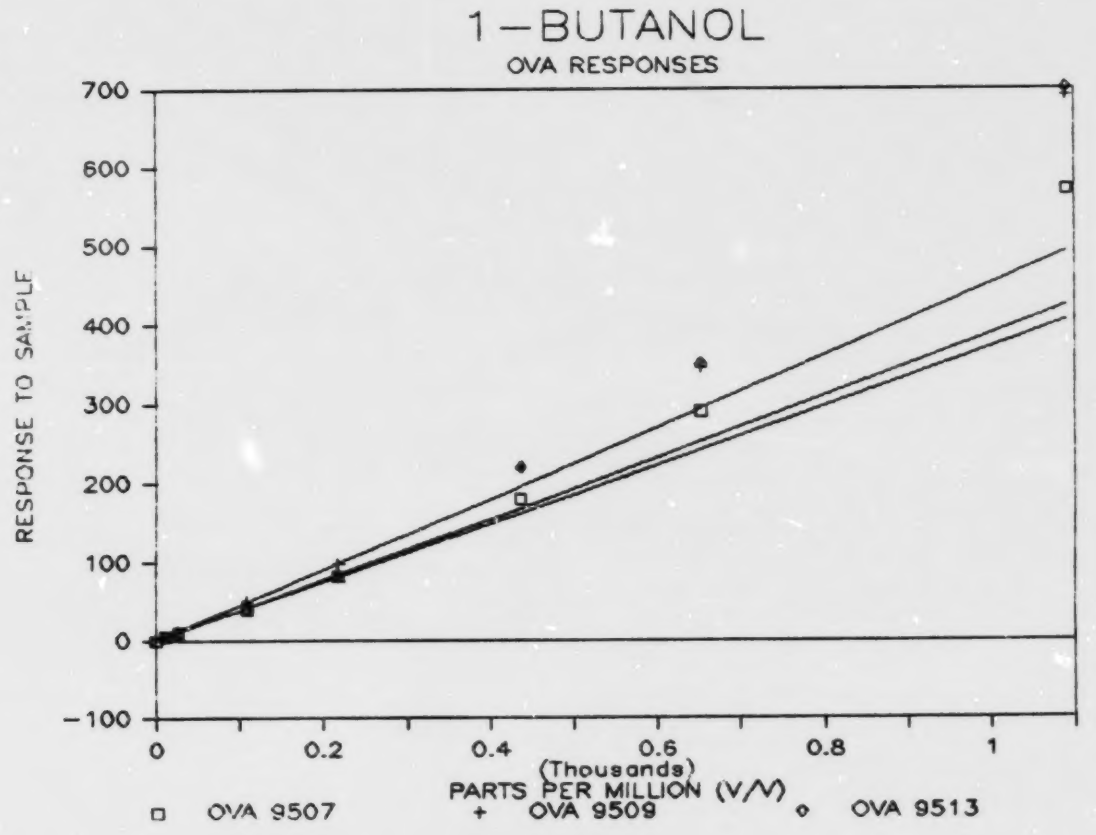
METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	8.00	9.10	7.40	----
Yes	93.00	87.50	92.50	86.00	----
No	498.00	475.00	510.00	555.00	----
	SLOPE=		0.9366	0.9910	0.9265
	INTERCEPT=		0.4444	0.3693	-0.1822
	CORRELATION COEFFICIENT=		1.0000	1.0000	1.0000

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	1.00	24.50	10.9	4.00	5.45	4.20	---
Yes	3.00	29.40	27.3	10.00	12.00	9.20	---
Yes	10.00	24.50	109.1	41.00	50.00	42.00	---
Yes	25.00	30.70	217.6	81.00	98.00	84.00	---
No	40.00	24.50	436.4	180.00	220.00	220.00	---
No	50.00	20.50	651.9	290.00	345.00	350.00	---
No	100.00	24.50	1090.9	570.00	690.00	700.00	---
	SLOPE=			0.3714	0.4506	0.3877	
	INTERCEPT=			0.2519	0.2033	-0.4131	
	CORRELATION COEFFICIENT=			0.9999	0.9999	0.9999	
OVA RELATIVE RESPONSE FACTOR _____				0.3966	0.4547	0.4184	


BENZENE
OVA RESPONSES
RESPONSE TO SAMPLE (Thousands)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
200
400
600
PARTS PER MILLION (V/V)
□ OVA 9507
+ OVA 9509
◇ OVA 9513


1-BUTANOL
OVA RESPONSES
RESPONSE TO SAMPLE
700
600
500
400
300
200
100
0
-100
0
0.2
0.4
0.6
0.8
1
(Thousands)
PARTS PER MILLION (V/V)
□ OVA 9507
+ OVA 9509
◇ OVA 9513

n-BUTYRALDEHYDE - OVA RELATIVE RESPONSE FACTORS

SYNONYM : n-BUTANAL
MOLECULAR WEIGHT : 72.1 DENSITY : 0.81 g/ml (20 C)
SAMPLE : KODAK, NO GRADE SPECIFIED DATE : 31 JANUARY, 1984

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	3.80	4.60	4.80	4.30	----
Yes	8.40	9.90	10.00	9.10	----
Yes	93.00	98.00	105.00	98.00	----
No	498.00	500.00	525.00	590.00	----
	SLOPE=	1.0464	1.1256	1.0519	
	INTERCEPT=	0.5528	0.3477	0.1849	
	CORRELATION COEFFICIENT=	1.0000	1.0000	1.0000	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	0.60	30.30	5.4	2.10	2.40	2.20	2.20
Yes	1.00	25.20	10.9	4.20	4.90	4.10	4.20
Yes	2.50	31.50	21.8	8.00	9.35	7.75	7.95
Yes	5.00	25.20	54.5	17.50	21.00	19.00	18.00
Yes	10.00	25.20	109.0	37.00	45.00	39.00	37.00
Yes	15.00	25.20	163.5	57.50	70.00	60.50	57.00
Yes	25.00	31.50	218.0	79.50	96.00	83.00	---
	SLOPE=			0.3589	0.4355	0.3766	
	INTERCEPT=			-0.4367	-0.6661	-0.5092	
	CORRELATION COEFFICIENT=			0.9992	0.9993	0.9995	
OVA RELATIVE RESPONSE FACTOR _____				0.3423	0.3870	0.3580	

CARBON TETRACHLORIDE - OVA RELATIVE RESPONSE FACTORS

SYNONYMS : TETRACHLOROMETHANE
MOLECULAR WEIGHT : 153.8 DENSITY : 1.58 g/ml (20 C)
SAMPLE : J.T. BAKER, REAGENT GRADE DATE : 19 JANUARY, 1984

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	3.80	4.50	4.90	4.50	----
Yes	8.40	9.80	10.00	9.45	----
Yes	93.00	97.50	99.00	105.00	----
No	498.00	500.00	535.00	600.00	----
	SLOPE=	1.0435	1.0581	1.1283	
	INTERCEPT=	0.5070	0.6465	0.0621	
	CORRELATION COEFFICIENT=	1.0000	0.9999	1.0000	

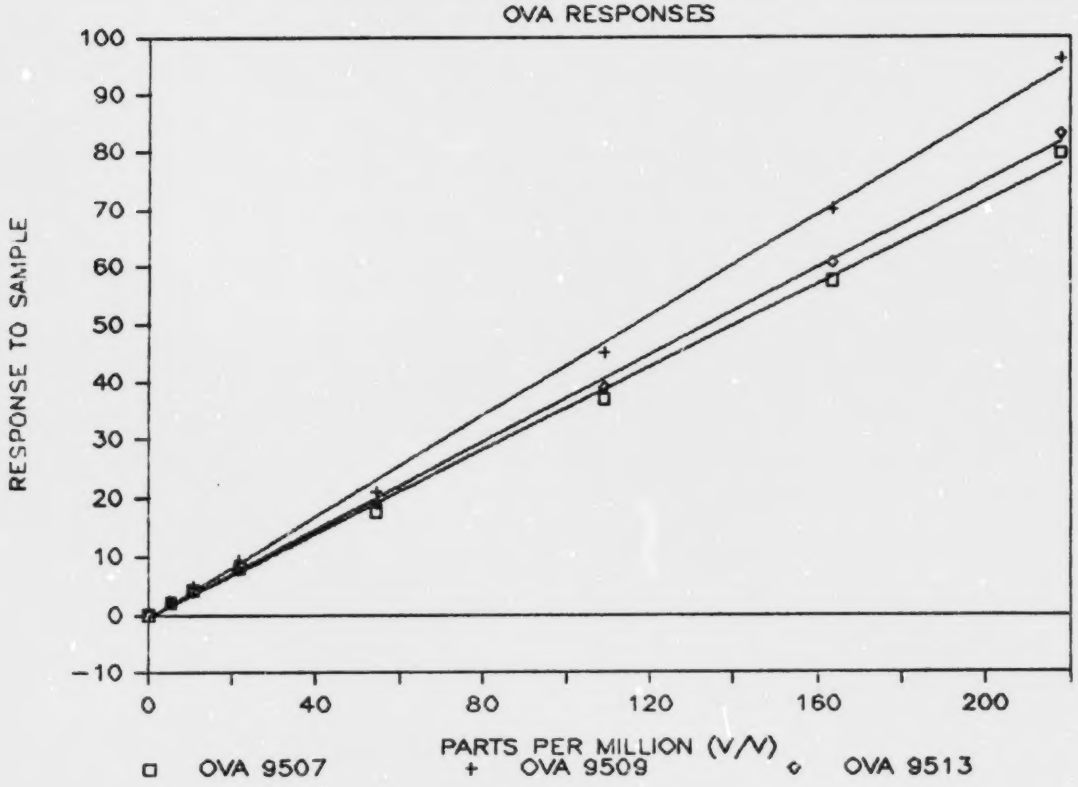
SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	0.00
Yes	3.00	23.10	32.6	2.00	2.70	2.00	2.00
Yes	8.00	23.10	87.0	5.40	7.00	5.40	5.40
Yes	35.00	26.90	326.8	18.50	23.50	20.50	18.50
Yes	80.00	30.80	652.4	37.00	46.00	42.50	39.50
Yes	100.00	23.10	1087.4	62.00	76.00	71.50	61.50
	SLOPE=			0.0568	0.0696	0.0658	
	INTERCEPT=			0.1278	0.5191	-0.3323	
	CORRELATION COEFFICIENT=			1.0000	0.9999	0.9999	
OVA RELATIVE RESPONSE FACTOR _____				0.0544	0.0657	0.0583	
	AIR BLANK			2.40	2.50	2.40	

NOTE : USED ZERO AIR FOR ALL BAG SAMPLES. ALL REPORTED SAMPLE READINGS ARE NET.
ZERO AIR CONTAINS LESS THAN 2 ppm TOTAL HYDROCARBONS AS METHANE.

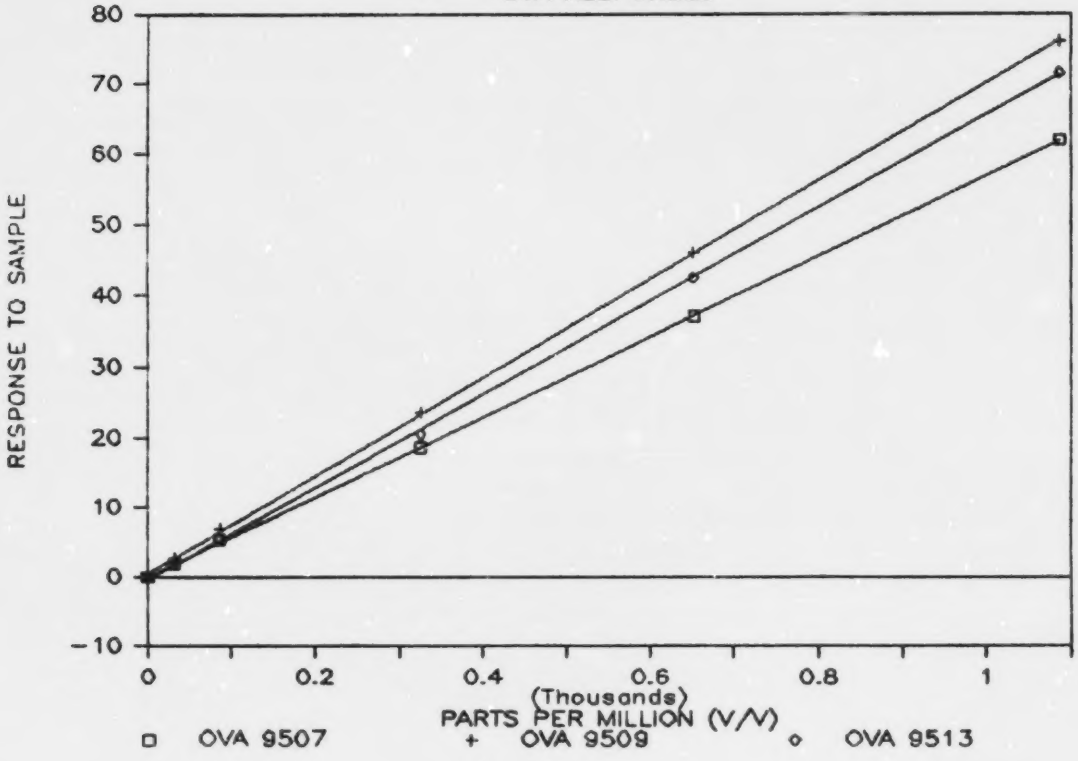
n—BUTYRALDEHYDE

OVA RESPONSES



CARBON TETRACHLORIDE

OVA RESPONSES



CHLOROFORM - OVA RELATIVE RESPONSE FACTORS

SYNONYMS : TRICHLOROMETHANE
MOLECULAR WEIGHT : 119.38 DENSITY : 1.48 g/ml (20 C)
SAMPLE : HACH, A.C.S. SPECTROSCOPY GRADE DATE : 18 JANUARY, 1984

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	10.00	8.30	8.10	----
Yes	93.00	97.00	86.00	97.50	----
Yes	498.00	510.00	485.00	500.00	----
	SLOPE=	1.0223	0.9754	1.1698	
	INTERCEPT=	1.2564	-1.3315	-3.8898	
	CORRELATION COEFFICIENT=	1.0000	1.0000	0.9998	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	0.00
Yes	0.50	27.80	5.5	2.90	3.00	2.60	2.90
Yes	1.00	27.80	10.9	6.80	7.00	6.00	6.60
Yes	3.00	27.80	32.7	17.00	18.00	18.00	17.00
Yes	7.50	27.80	81.8	46.00	47.00	47.00	44.50
Yes	10.00	22.30	135.9	70.00	72.00	74.00	69.50
Yes	10.00	22.30	135.9	70.00	73.00	75.00	69.50
Yes	25.00	27.80	272.6	130.00	145.00	155.00	130.00
Yes	50.00	27.80	545.2	250.00	290.00	300.00	----
Yes	100.00	27.80	1090.4	490.00	565.00	590.00	480.00
		SLOPE=		0.4474	0.5190	0.5423	
		INTERCEPT=		4.8915	2.0676	1.4418	
		CORRELATION COEFFICIENT=		0.9997	0.9999	0.9999	
	OVA RELATIVE RESPONSE FACTOR _____			0.4376	0.5321	0.4636	
		AIR BLANK		2.60	2.00	2.10	

NOTE : USED ZERO AIR FOR ALL BAG SAMPLES. ALL REPORTED SAMPLE READINGS ARE NET.

CUMENE - OVA RELATIVE RESPONSE FACTORS

SYNONYM : ISOPROPYL BENZENE
MOLECULAR WEIGHT : 120.2 DENSITY : 0.86 g/ml (20 C)
SAMPLE : POLYSCIENCE , QUANTITATIVE GRADE (See Note) DATE:16 DEC., 1983

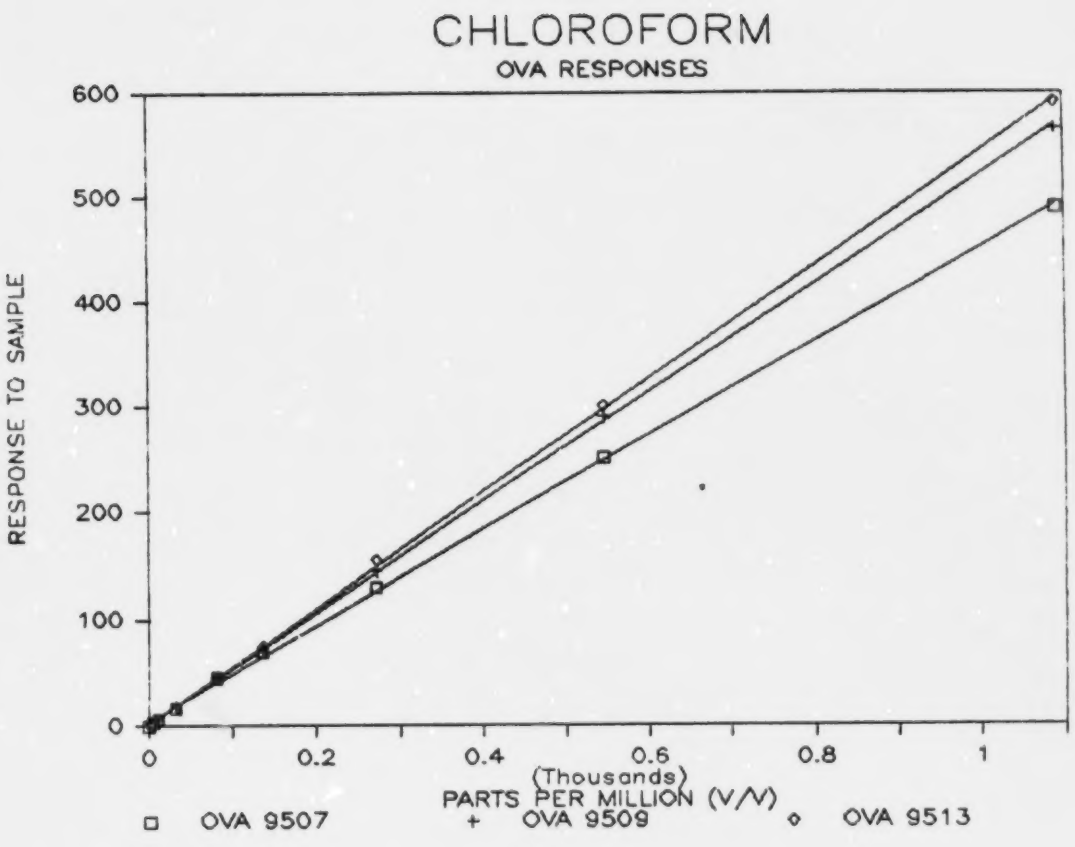
METHANE STANDARDS
****

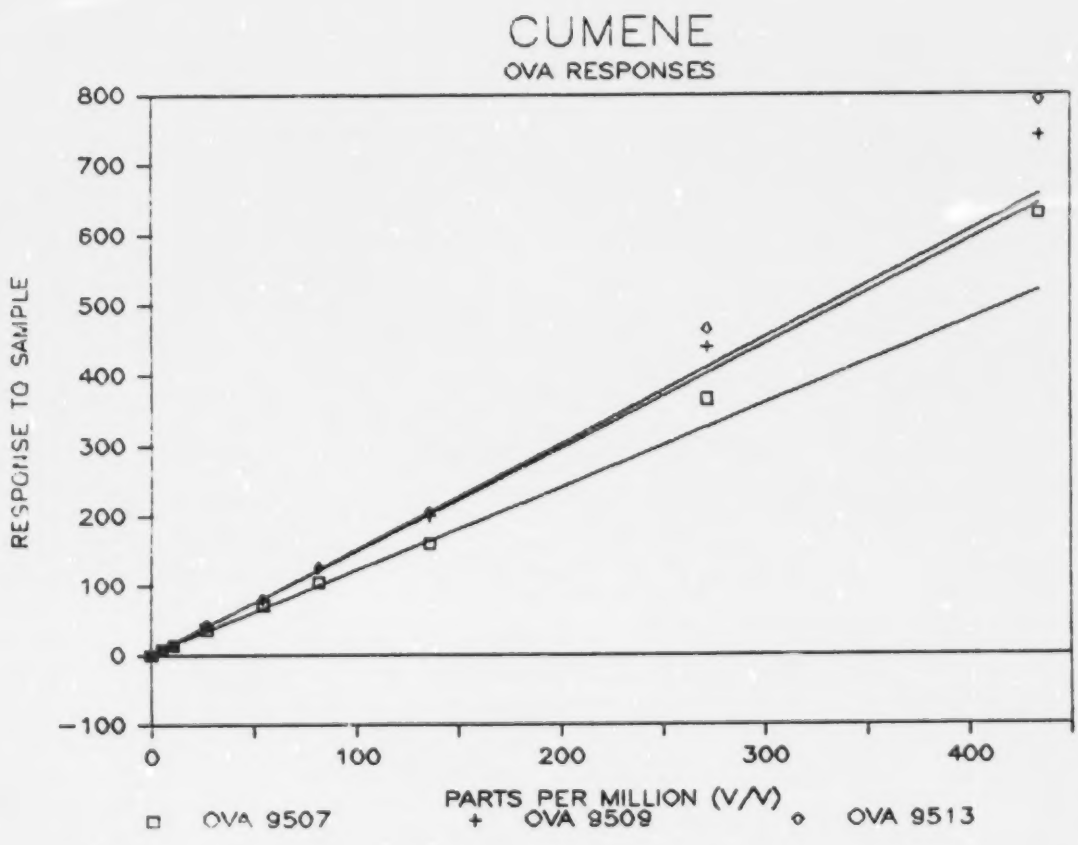
Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	9.60	9.00	8.30	----
Yes	93.00	93.50	90.00	99.00	----
Yes	490.00	490.00	490.00	500.00	----
	SLOPE=	0.9821	0.9838	1.1691	
	INTERCEPT=	1.1035	-0.1763	-3.3628	
	CORRELATION COEFFICIENT=	1.0000	1.0000	0.9999	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	1.00	32.10	5.4	8.25	8.00	7.40	---
Yes	1.50	24.10	10.9	14.50	16.00	16.00	---
Yes	5.00	32.10	27.2	37.00	42.00	42.00	---
Yes	8.00	25.70	54.5	72.00	80.00	80.00	---
Yes	15.00	32.10	81.7	105.00	125.00	125.00	---
Yes	20.00	25.70	136.1	160.00	200.00	205.00	---
No	40.00	25.70	272.3	365.00	440.00	465.00	---
No	50.00	20.10	435.1	630.00	740.00	790.00	
		SLOPE=		1.1875	1.4768	1.5112	
		INTERCEPT=		3.0845	0.7525	-0.2888	
		CORRELATION COEFFICIENT=		0.9981	0.9997	0.9999	
	OVA RELATIVE RESPONSE FACTOR _____			1.2091	1.5011	1.2927	

NOTES : GC ANALYSIS REVEALED TWO MAJOR COMPONENTS IN THE ISOPROPYL BENZENE.


CHLOROFORM
OVA RESPONSES
RESPONSE TO SAMPLE
600
500
400
300
200
100
0
0
0.2
0.4
0.6
0.8
1
(Thousands)
PARTS PER MILLION (V/V)
OVA 9507
OVA 9509
OVA 9513


CUMENE
OVA RESPONSES
RESPONSE TO SAMPLE
800
700
600
500
400
300
200
100
0
-100
0
100
200
300
400
PARTS PER MILLION (V/V)
OVA 9507
OVA 9509
OVA 9513

CYCLOHEXANE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 84.2 DENSITY : 0.774 g/ml (25 C)
SAMPLE : J.T. BAKER, REAGENT GRADE DATE : 13 DECEMBER, 1983

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	8.90	9.60	8.00	----
Yes	93.00	88.00	94.00	94.00	----
Yes	498.00	480.00	520.00	600.00	----
	SLOPE=	0.9637	1.0445	1.2128	
	INTERCEPT=	-0.1903	-0.6233	-6.2327	
	CORRELATION COEFFICIENT=	1.0000	1.0000	0.9996	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	0.70	28.90	5.4	3.70	4.50	3.50	---
Yes	3.00	24.80	27.2	16.50	20.50	18.00	---
Yes	5.00	20.60	54.6	32.00	40.50	37.00	---
Yes	10.00	20.60	109.1	71.00	86.50	80.00	---
Yes	25.00	25.80	217.8	145.00	170.00	185.00	---
No	25.30	17.20	326.7	240.00	290.00	310.00	---
No	50.00	20.60	545.5	425.00	520.00	560.00	---
No	100.00	22.90	981.4	940.00	1000.00	1000.00	---
	SLOPE=		0.6675	0.7834	0.8469		
	INTERCEPT=		-1.3656	-0.3991	-4.5298		
	CORRELATION COEFFICIENT=		0.9995	0.9999	0.9971		
OVA RELATIVE RESPONSE FACTOR _____			0.6926	0.7500	0.6983		

1,2-DIBROMOETHANE - OVA RELATIVE RESPONSE FACTORS

SYNONYMS : ETHYLENE DIBROMIDE, EDB
MOLECULAR WEIGHT : 187.9 DENSITY : 2.18 g/ml (20 C)
SAMPLE : J.T. BAKER, "BAKER" GRADE DATE : 03 JANUARY, 1984

METHANE STANDARDS
****

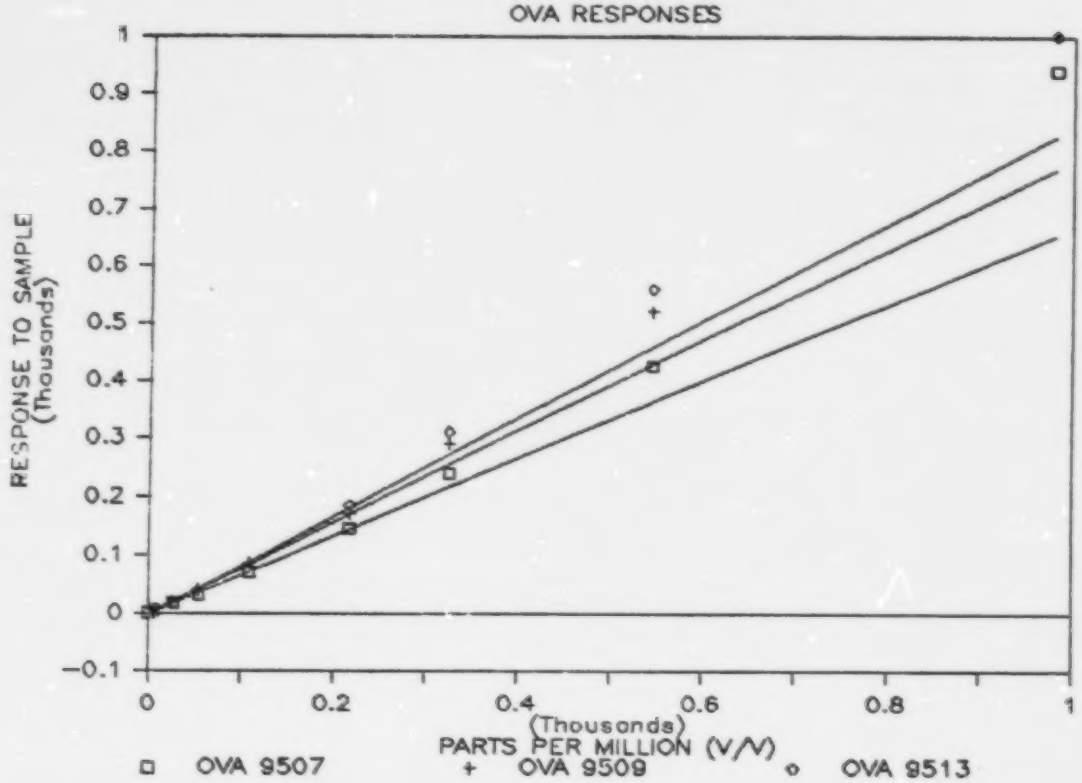
Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	9.30	8.60	8.10	----
Yes	93.00	92.00	89.00	99.00	----
Yes	498.30	485.00	498.00	590.00	----
	SLOPE=	0.9725	0.9845	1.1901	
	INTERCEPT=	0.8518	-0.6281	-4.0640	
	CORRELATION COEFFICIENT=	1.0000	1.0000	0.9998	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	0.50	26.10	5.4	3.60	3.50	3.20	---
Yes	2.00	34.70	16.3	9.50	9.50	8.60	---
Yes	5.00	26.10	54.3	31.00	32.50	34.00	---
Yes	10.00	26.10	108.7	59.00	62.00	65.50	---
Yes	15.00	26.10	163.0	92.00	95.00	100.00	---
Yes	25.00	21.70	326.8	190.00	200.00	230.00	---
No	50.00	21.70	653.6	400.00	440.00	500.00	---
No	100.00	28.90	981.6	650.00	695.00	810.00	
	SLOPE=			0.5507	0.6082	0.6960	
	INTERCEPT=			0.5060	-1.1154	-4.0357	
	CORRELATION COEFFICIENT=			0.9999	0.9996	0.9975	
OVA RELATIVE RESPONSE FACTOR _____				0.5663	0.6177	0.5848	

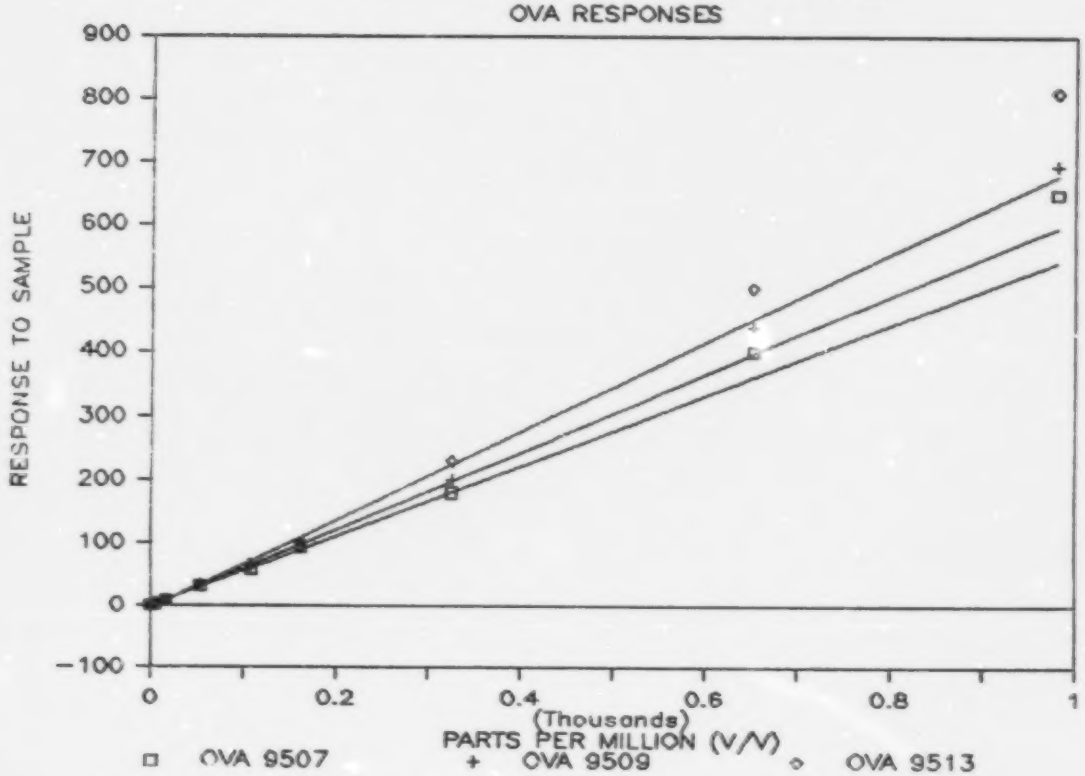
CYCLOHEXANE

OVA RESPONSES



1,2−DIBROMOETHANE

OVA RESPONSES



1,2-DICHLOROBENZENE - OVA RELATIVE RESPONSE FACTORS

SYNONYM: o-DICHLOROBENZENE
MOLECULAR WEIGHT : 147.0 DENSITY : 1.302 g/ml (25 C)
SAMPLE : J.T. BAKER, REAGENT GRADE DATE : 05 DECEMBER, 1983

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	9.20	10.10	9.00	----
Yes	93.00	91.50	110.00	98.50	----
Yes	490.00	490.00	620.00	590.00	----
Yes	490.00	505.00	640.00	640.00	----
	SLOPE=	0.9990	1.2691	1.2439	
	INTERCEPT=	-0.1257	-2.5327	-5.5057	
	CORRELATION COEFFICIENT=	0.9998	0.9997	0.9982	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	1.00	39.60	5.4	10.10	12.50	10.00	---
Yes	1.00	19.90	10.9	18.00	24.00	19.50	---
Yes	3.00	29.80	21.8	37.00	50.00	41.00	---
Yes	5.00	24.90	43.5	78.00	100.00	81.00	---
Yes	10.00	24.90	87.0	150.00	200.00	180.00	---
Yes	15.00	24.90	130.5	230.00	310.00	275.00	---
Yes	25.00	24.90	217.4	350.00	515.00	475.00	---
No	50.00	24.90	434.9	770.00	1000.00	1000.00	---
	SLOPE=			1.6395	2.3726	2.1840	
	INTERCEPT=			3.7648	-1.9821	-6.6391	
	CORRELATION COEFFICIENT=			0.9986	0.9999	0.9995	
OVA RELATIVE RESPONSE FACTOR _____				1.6411	1.8694	1.7558	

NOTES : All sample readings taken after 3 minutes of continuous sampling.
Slow response.

1,2-DICHLORDETHANE - OVA RELATIVE RESPONSE FACTORS

SYNONYM: ETHYLENE DICHLORIDE
MOLECULAR WEIGHT : 99.0 DENSITY : 1.26 g/ml
SAMPLE : J.T. BAKER, F.C.C. FOOD GRADE DATE : 27 JANUARY, 1984

METHANE STANDARDS
****

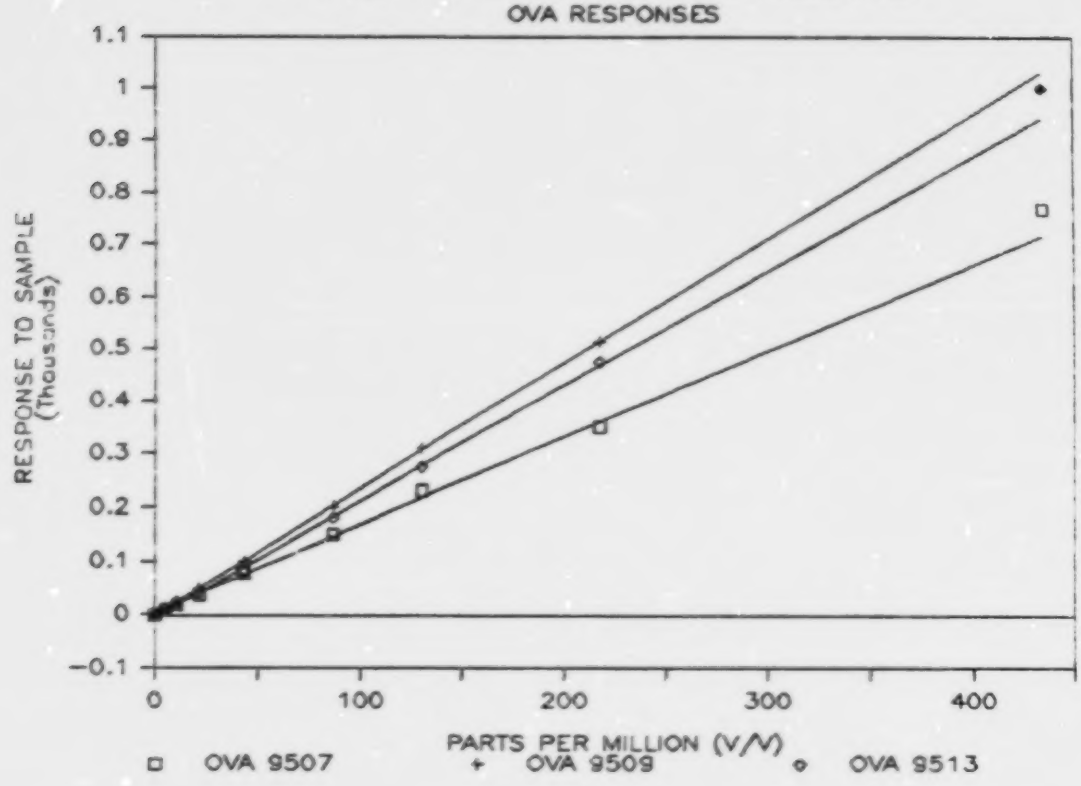
Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	3.00	4.65	4.20	4.30	----
Yes	8.40	10.00	9.10	9.20	----
Yes	93.00	95.20	84.50	99.00	----
No	498.00	495.00	470.00	580.00	----
	SLOPE=	1.0144	0.9014	1.0628	
	INTERCEPT=	0.7351	0.7437	0.1739	
	CORRELATION COEFFICIENT=	0.9999	0.9999	1.0000	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	0.00
Yes	0.60	34.30	5.4	5.55	5.30	5.10	5.50
Yes	0.80	25.40	9.8	9.25	9.10	8.75	9.25
Yes	3.00	34.30	27.2	22.00	22.00	24.00	22.00
Yes	5.00	26.60	54.4	46.00	44.00	49.00	45.00
Yes	9.00	32.10	87.2	70.00	68.00	75.50	70.00
Yes	10.00	28.60	108.8	89.00	85.50	95.00	88.00
No	20.00	28.60	217.6	165.00	170.00	200.00	165.00
No	25.00	23.60	326.9	230.00	250.00	290.00	230.00
No	50.00	28.60	544.0	395.00	425.00	495.00	390.00
		SLOPE=		0.8072	0.7767	0.8700	
		INTERCEPT=		0.7656	0.9144	0.3582	
		CORRELATION COEFFICIENT=		0.9997	0.9998	0.9999	
OVA RELATIVE RESPONSE FACTOR _____				0.7958	0.8617	0.8186	

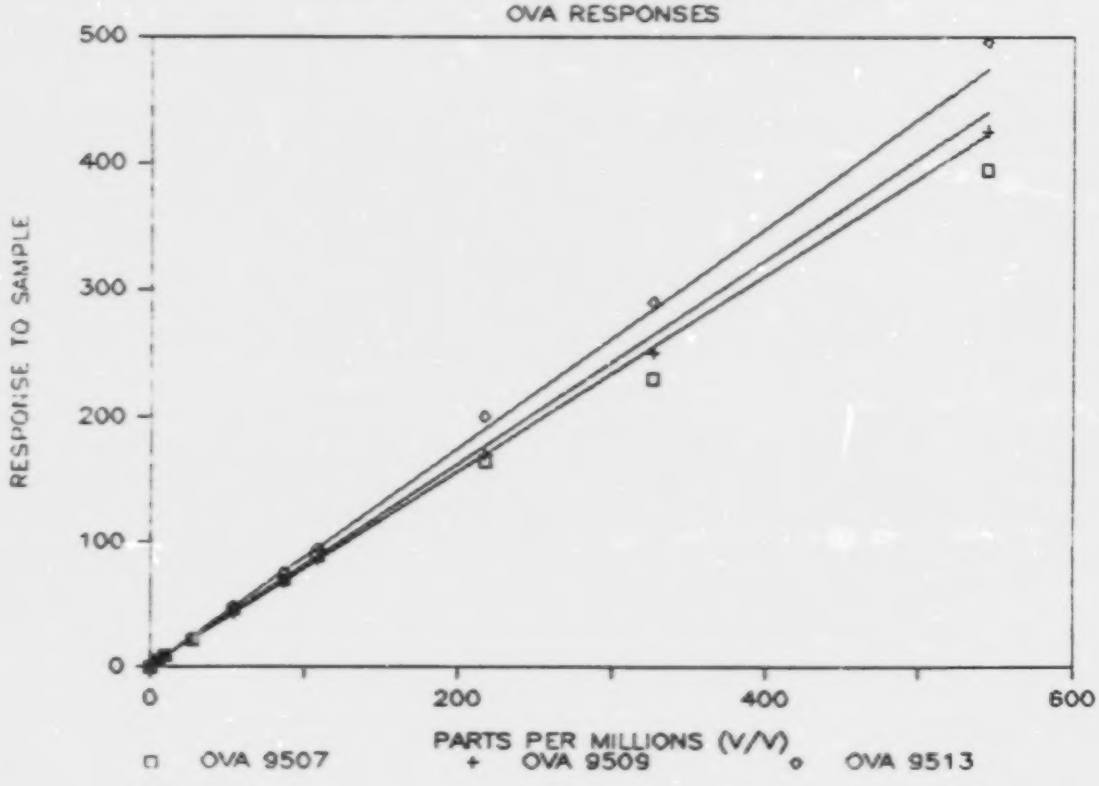
1,2-DICHLOROBENZENE

OVA RESPONSES



1,2-DICHLOROETHANE

OVA RESPONSES



ETHANOL - OVA RELATIVE RESPONSE FACTORS

SYNONYMS : ETHYL ALCOHOL
MOLECULAR WEIGHT : 46.07 DENSITY : 0.785 g/ml (20 C)
SAMPLE : CONSOLIDATED ALCOHOLS, ABSOLUTE DATE : 19 JANUARY, 1984

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	3.90	4.35	4.55	4.25	----
Yes	8.40	9.85	9.95	9.30	----
Yes	93.00	97.00	94.50	105.00	----
No	498.00	500.00	530.00	605.00	----
	SLOPE=	1.0383	1.0093	1.1297	
	INTERCEPT=	0.4930	0.7057	-0.0746	
	CORRELATION COEFFICIENT=	0.9999	0.9999	1.0000	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	----
Yes	1.00	19.10	21.8	5.50	6.00	5.50	----
Yes	3.50	26.00	54.4	12.00	13.50	13.00	----
Yes	9.00	23.00	163.2	38.00	43.00	43.00	----
Yes	20.00	25.50	326.8	76.00	86.00	85.50	----
Yes	30.00	23.00	543.4	125.00	145.00	150.00	----
No	75.00	28.70	1088.7	265.00	320.00	335.00	----
No	120.00	23.00	2173.6	610.00	725.00	770.00	----
	SLOPE=			0.2385	0.2668	0.2748	
	INTERCEPT=			0.1386	-0.1375	-1.3160	
	CORRELATION COEFFICIENT=			1.0000	0.9999	0.9995	
OVA RELATIVE RESPONSE FACTOR _____				0.2220	0.2636	0.2433	

AIR BLANK 2.00 2.00 2.00

NOTE : USED ZERO AIR FOR ALL BAG SAMPLES. ALL REPORTED SAMPLE READINGS ARE NET.
ZERO AIR CONTAINS LESS THAN 2 ppm TOTAL HYDROCARBONS AS METHANE.

ETHYL BENZENE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 106.2 DENSITY : 0.87 g/ml (20 C)
SAMPLE : POLYSCIENCE, "QUANTITATIVE" GRADE (See Note) DATE : 05 JANUARY, 1984

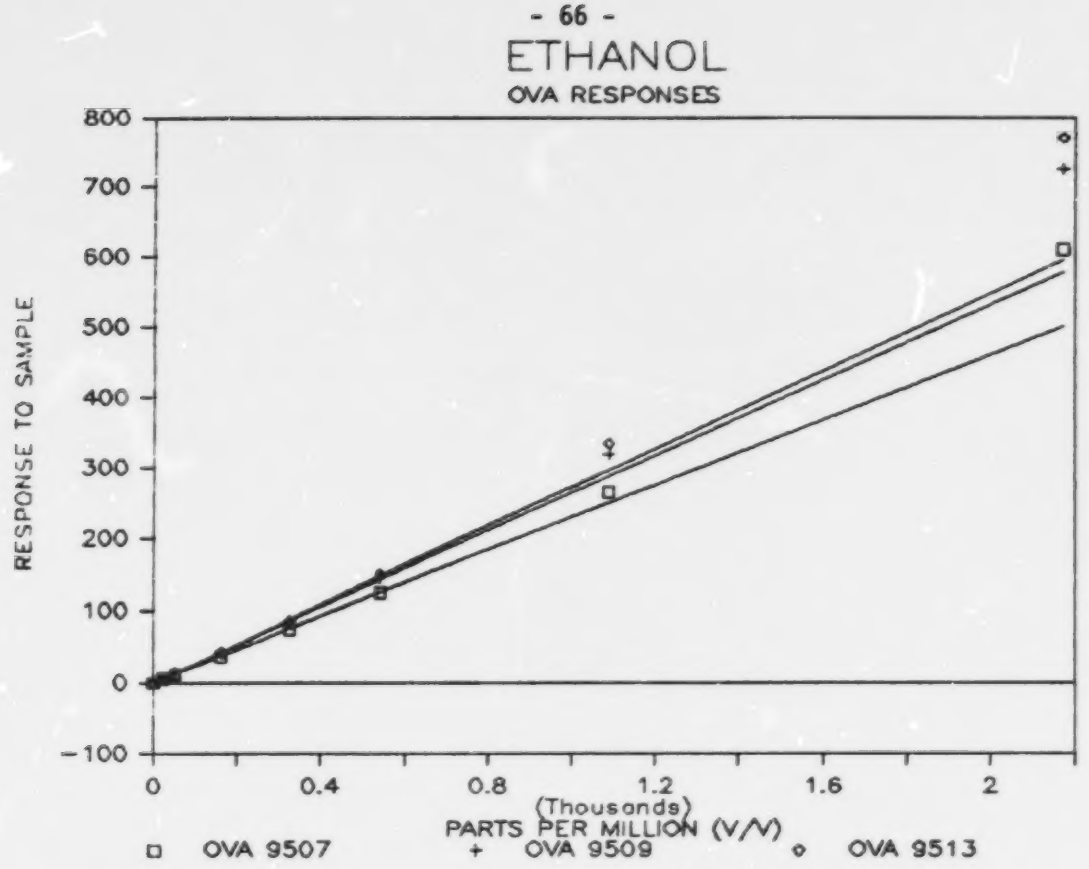
METHANE STANDARDS

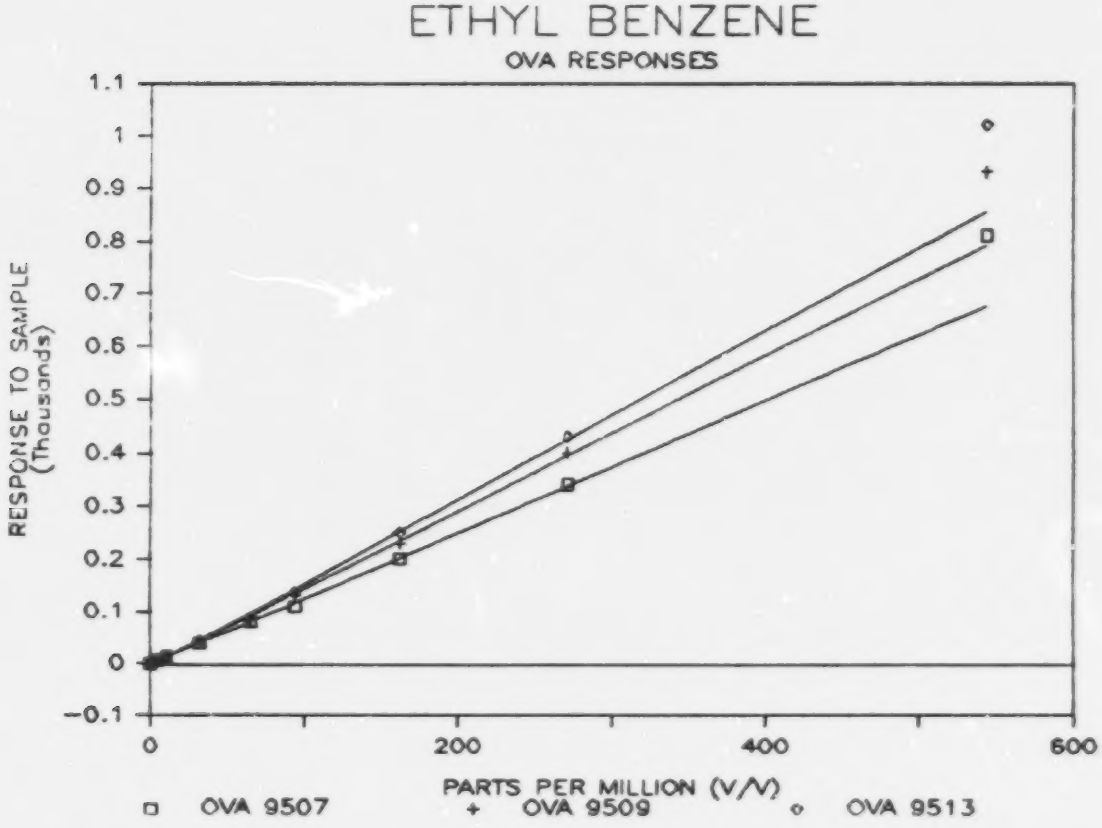
Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	9.60	9.05	8.30	----
Yes	93.00	94.00	90.00	99.00	----
Yes	498.00	490.00	495.00	500.00	----
	SLOPE=	0.9820	0.9942	1.1691	
	INTERCEPT=	1.2541	-0.4703	-3.3628	
	CORRELATION COEFFICIENT=	1.0000	1.0000	0.9999	

SAMPLE

LR	Sample (g)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	1.00	36.80	5.4	7.20	7.70	6.40	---
Yes	1.00	18.40	10.9	13.00	15.00	14.00	---
Yes	5.00	38.70	32.6	40.00	45.00	44.00	---
Yes	10.00	38.70	65.2	80.00	86.50	87.00	---
Yes	10.00	21.20	94.5	110.00	120.00	135.00	---
Yes	25.00	38.70	163.1	200.00	230.00	250.00	---
Yes	25.00	18.40	272.1	340.00	400.00	430.00	---
No	100.00	36.80	544.3	810.00	930.00	1020.00	---
	SLOPE=		1.2437	1.4611	1.5825		
	INTERCEPT=		-1.3352	-3.3284	-6.5788		
	CORRELATION COEFFICIENT=		0.9997	0.9995	0.9992		
OVA RELATIVE RESPONSE FACTOR _____			1.2666	1.4696	1.3536		

NOTES : GC ANALYSIS REVEALED TWO MAJOR COMPONENTS IN THE ETHYL BENZENE.


ETHANOL
OVA RESPONSES
RESPONSE TO SAMPLE
800
700
600
500
400
300
200
100
0
-100
0
0.4
0.8
1.2
1.6
2
(Thousands)
PARTS PER MILLION (V/V)
OVA 9507
OVA 9509
OVA 9513


ETHYL BENZENE
OVA RESPONSES
RESPONSE TO SAMPLE
(Thousands)
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
200
400
600
PARTS PER MILLION (V/V)
OVA 9507
OVA 9509
OVA 9513

2-ETHYL HEXANOL - OVA RELATIVE RESPONSE FACTORS

SYNONYMS : 2-ETHYL-1-HEXANOL
MOLECULAR WEIGHT : 130.2 DENSITY : 0.83 g/ml (20 C)
SAMPLE : KODAK, 99% MINIMUM DATE : 16 JANUARY, 1984

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	9.70	8.70	8.10	----
Yes	93.00	96.50	92.50	95.50	----
	SLOPE=	1.0329	0.9930	1.0294	
	INTERCEPT=	0.4876	0.1710	-0.2606	
	CORRELATION COEFFICIENT=	1.0000	1.0000	1.0000	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	----
Yes	1.50	42.90	5.4	3.60	4.10	3.30	----
Yes	2.50	35.80	10.9	7.70	8.00	7.20	----
Yes	8.00	36.20	32.6	20.50	26.00	23.00	----
Yes	16.00	36.20	65.3	44.50	52.00	48.00	----
Yes	25.00	35.80	108.8	76.00	89.00	80.00	----
	SLOPE=			0.6965	0.8176	0.7404	
	INTERCEPT=			-0.5136	-0.5518	-0.6128	
	CORRELATION COEFFICIENT=			0.9995	0.9999	0.9999	
OVA RELATIVE RESPONSE FACTOR _____				0.6743	0.8234	0.7192	
	AIR BLANK			2.40	1.90	1.90	

NOTE : USED ZERO AIR FOR ALL BAG SAMPLES. ALL REPORTED SAMPLE READINGS ARE NET.
ZERO AIR CONTAINS LESS THAN 2 ppm TOTAL HYDROCARBONS AS METHANE.

VERY SLOW RESPONSE AT ALL CONCENTRATIONS. REQUIRED 5 MINUTES SAMPLING PER READING.

HEXANE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 86.2 DENSITY : 0.66 g/ml (20 C)
SAMPLE : J.T. BAKER, PHOTREX REAGENT GRADE DATE : 10 JANUARY, 1984

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	3.00	0.00	0.00	----
Yes	8.40	9.80	8.90	9.20	----
Yes	93.00	97.00	98.00	100.00	----
No	498.00	510.00	505.00	500.00	----
	SLOPE=		1.0336	1.0535	1.0793
	INTERCEPT=		0.5147	0.0240	-0.4124
	CORRELATION COEFFICIENT=		0.9999	1.0000	1.0000

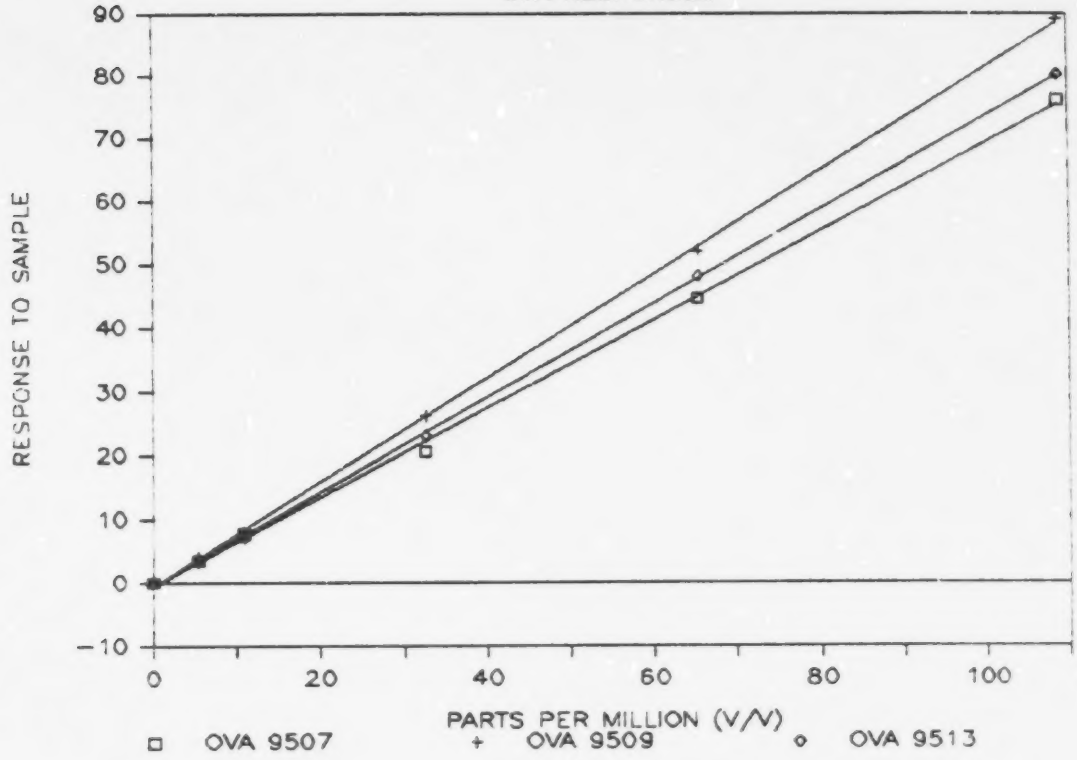
SAMPLE
****

LR	Sample (cc)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	1.00	34.40	5.4	4.60	4.60	4.00	---
Yes	2.00	34.40	10.9	8.80	9.10	7.80	---
Yes	5.00	28.70	32.6	27.00	26.50	25.00	---
Yes	10.00	28.70	65.2	51.50	56.50	54.00	---
Yes	20.00	30.20	98.0	72.00	83.00	78.00	---
No	25.00	28.70	163.1	125.00	140.00	145.00	---
No	50.00	28.70	326.1	270.00	305.00	320.00	---
No	100.00	34.43	544.2	520.00	590.00	620.00	
No	100.00	24.60	761.0	835.00	930.00	990.00	
	SLOPE=			0.7441	0.8526	0.8885	
	INTERCEPT=			0.3368	-0.2019	-0.4582	
	CORRELATION COEFFICIENT=			0.9986	0.9998	0.9995	
OVA RELATIVE RESPONSE FACTOR _____				0.7169	0.8093	0.7491	

NOTES : PROBLEM SUDDENLY DEVELOPED WITH 9509 HYDROGEN SUPPLY.
DISCUSSED IN REPORT BODY.

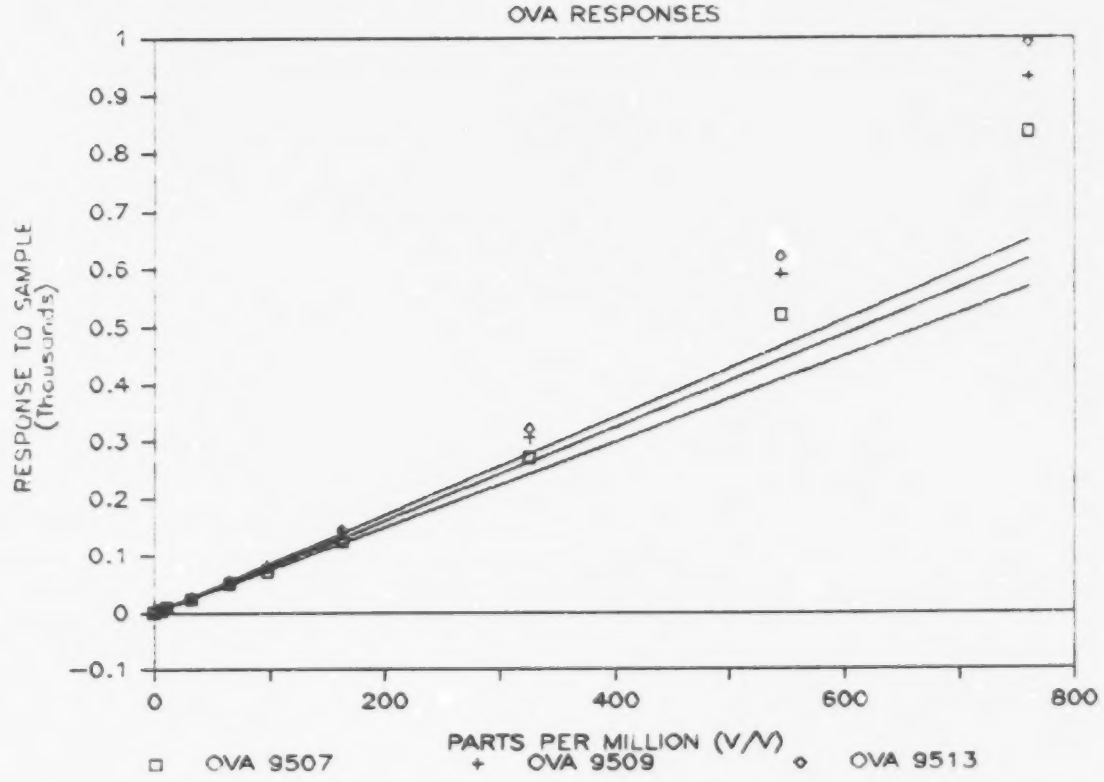
2-ETHYL HEXANOL

OVA RESPONSES



HEXANE

OVA RESPONSES



ISOPROPANOL - OVA RELATIVE RESPONSE FACTORS

SYNONYMS : 2-PROPANOL, ISOPROPYL ALCOHOL
MOLECULAR WEIGHT : 60.1 DENSITY : 0.78 g/ml (25 C)
SAMPLE : FISHER, A.C.S. REAGENT GRADE DATE : 11 JANUARY, 1984

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	9.50	9.30	8.10	----
Yes	93.00	97.00	99.50	96.00	----
Yes	498.00	505.00	545.00	590.00	----
	SLOPE=	1.0123	1.0951	1.1911	
	INTERCEPT=	1.1806	-0.6451	-4.9671	
	CORRELATION COEFFICIENT=	1.0000	1.0000	0.9997	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	1.00	29.10	10.9	6.70	7.50	6.10	---
Yes	2.50	29.10	27.3	16.00	18.00	17.00	---
Yes	5.00	29.10	54.5	30.00	35.00	33.00	---
Yes	10.00	29.10	109.0	62.00	71.50	66.50	---
Yes	20.00	29.10	218.1	125.00	150.00	145.00	---
Yes	40.00	29.10	436.2	255.00	310.00	310.00	---
No	70.00	29.10	763.3	470.00	570.00	570.00	---
No	100.00	29.10	1090.4	720.00	885.00	870.00	
	SLOPE=			0.5837	0.7106	0.7106	
	INTERCEPT=			-0.7117	-2.3500	-4.3855	
	CORRELATION COEFFICIENT=			0.9999	0.9997	0.9992	
OVA RELATIVE RESPONSE FACTOR _____				0.5766	0.6491	0.5966	

METHYL ETHYL KETONE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 72.1 DENSITY : 0.800 g/ml (20 C)
SAMPLE : J.T. BAKER, REAGENT GRADE DATE : 30 NOVEMBER, 1983

METHANE STANDARDS
****

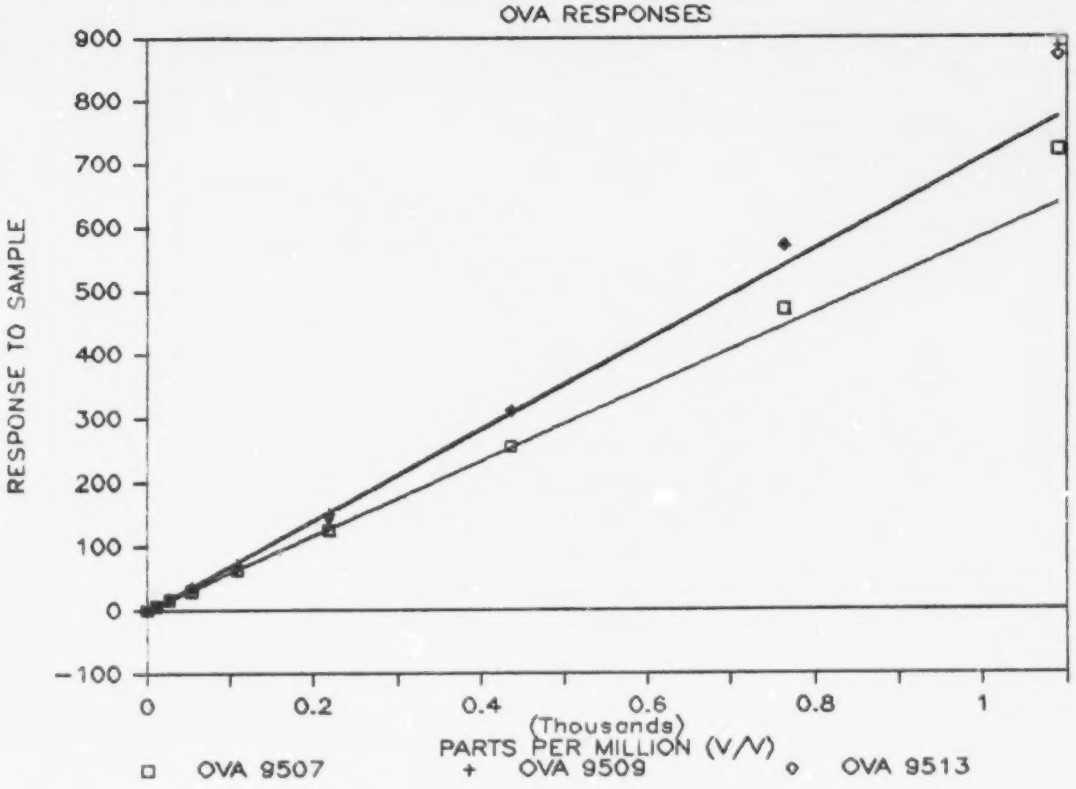
Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	9.00	11.00	9.50	----
Yes	93.00	89.00	115.00	96.00	----
No	498.00	495.00	640.00	580.00	----
	SLOPE=	0.9524	1.2336	1.0331	
	INTERCEPT=	0.4764	0.3037	-0.0847	
	CORRELATION COEFFICIENT=	0.9999	1.0000	1.0000	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	0.50	27.10	5.0	4.70	6.70	4.90	---
Yes	3.00	32.60	25.0	15.00	22.00	16.00	---
Yes	5.00	27.10	50.1	29.00	44.00	33.00	---
Yes	10.00	27.10	100.1	57.00	84.00	63.00	---
Yes	25.00	27.10	250.3	140.00	220.00	170.00	---
No	50.00	27.10	500.5	330.00	520.00	400.00	---
No	100.20	27.10	1001.1	670.00	1020.00	820.00	---
	SLOPE=	0.5557	0.8731	0.6754			
	INTERCEPT=	1.0913	0.1559	-0.6296			
	CORRELATION COEFFICIENT=	0.9999	0.9997	0.9994			
OVA RELATIVE RESPONSE FACTOR _____		0.5834	0.7077	0.6537			

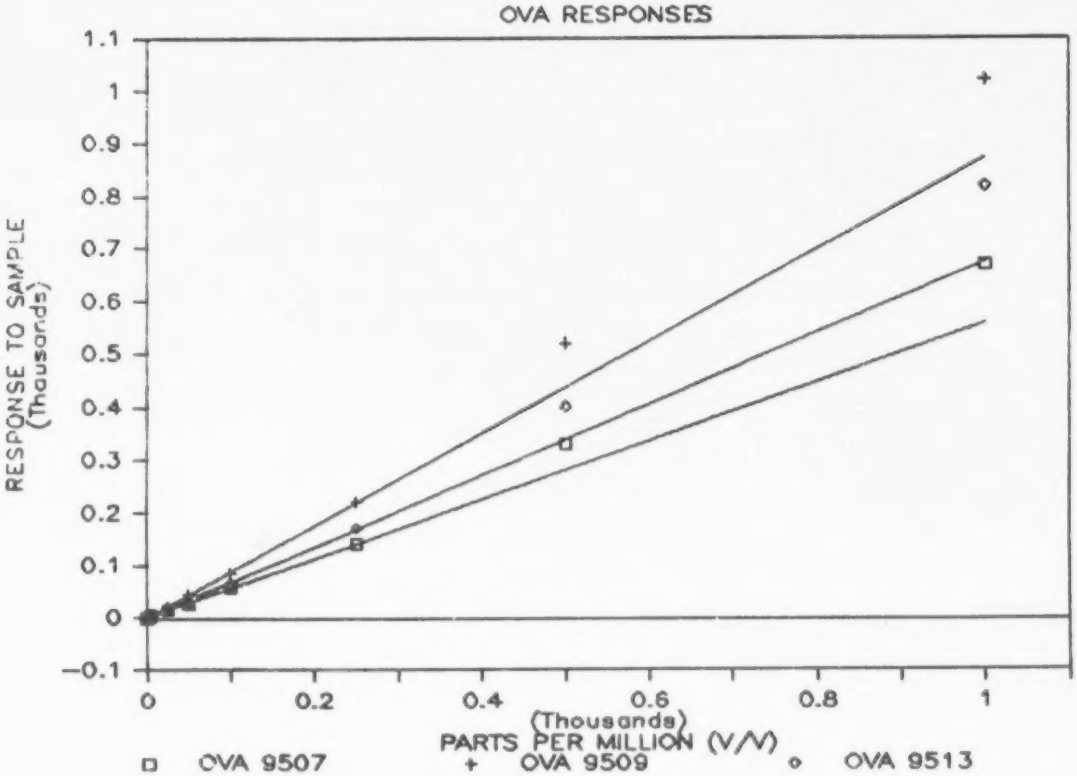
ISOPROPANOL

OVA RESPONSES



MEK

OVA RESPONSES



METHANOL - OVA RELATIVE RESPONSE FACTORS

SYNONYMS : METHYL ALCOHOL
MOLECULAR WEIGHT : 32.04 DENSITY : 0.79 g/ml (20 C)
SAMPLE : SARGENT-WELCH, REAGENT GRADE DATE : 18 JANUARY, 1984

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	3.80	4.30	4.30	4.65	----
Yes	8.40	9.75	10.10	9.35	----
Yes	93.00	96.00	94.00	105.00	----
No	498.00	500.00	510.00	600.00	----
	SLOPE=	1.0276	1.0042	1.1281	
	INTERCEPT=	0.4867	0.6897	0.0816	
	CORRELATION COEFFICIENT=	0.9999	0.9999	1.0000	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	0.00
Yes	1.00	18.50	32.6	3.30	4.85	3.55	3.30
Yes	3.00	23.70	76.3	7.55	9.50	7.90	7.55
Yes	10.00	27.70	217.6	20.00	27.50	24.00	20.00
Yes	25.00	27.70	544.1	50.00	68.00	60.00	50.00
Yes	40.00	27.70	870.6	86.00	113.00	100.00	86.00
Yes	40.00	27.70	870.6	83.00	106.00	97.50	82.50
	SLOPE=			0.0966	0.1265	0.1135	
	INTERCEPT=			-0.3572	0.0522	-0.5092	
	CORRELATION COEFFICIENT=			0.9993	0.9995	0.9998	
	OVA RELATIVE RESPONSE FACTOR _____			0.0940	0.1260	0.1006	
	AIR BLANK			2.10	2.10	2.10	

NOTE : USED ZERO AIR FOR ALL BAG SAMPLES. ALL REPORTED SAMPLE READINGS ARE NET.
ZERO AIR CONTAINS LESS THAN 2 ppm TOTAL HYDROCARBONS AS METHANE.

CALIBRATION OF 9509 AND 9513 ADJUSTED THIS DATE.

METHYLENE CHLORIDE - OVA RELATIVE RESPONSE FACTORS

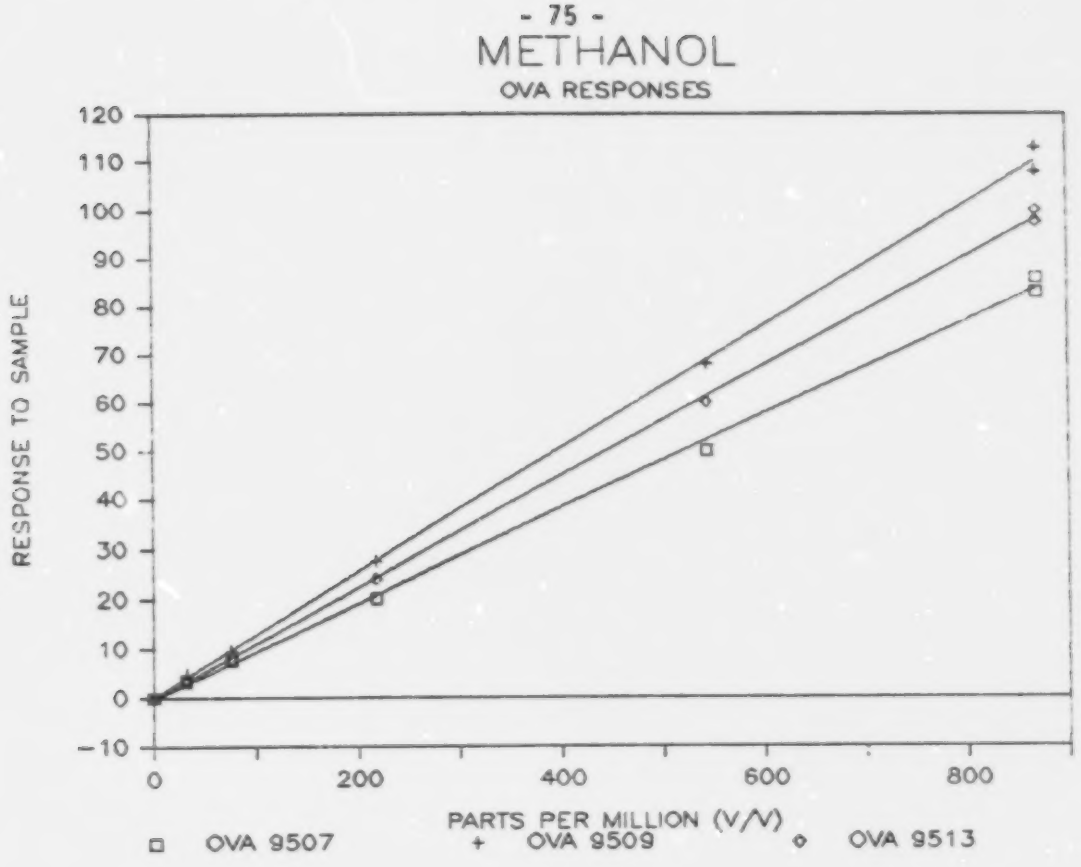
SYNONYMS : DICHLOROMETHANE
MOLECULAR WEIGHT : 84.93 DENSITY : 1.325 g/ml (20 C)
SAMPLE : SARGENT-WELCH, REAGENT GRADE DATE : 20 JANUARY, 1984

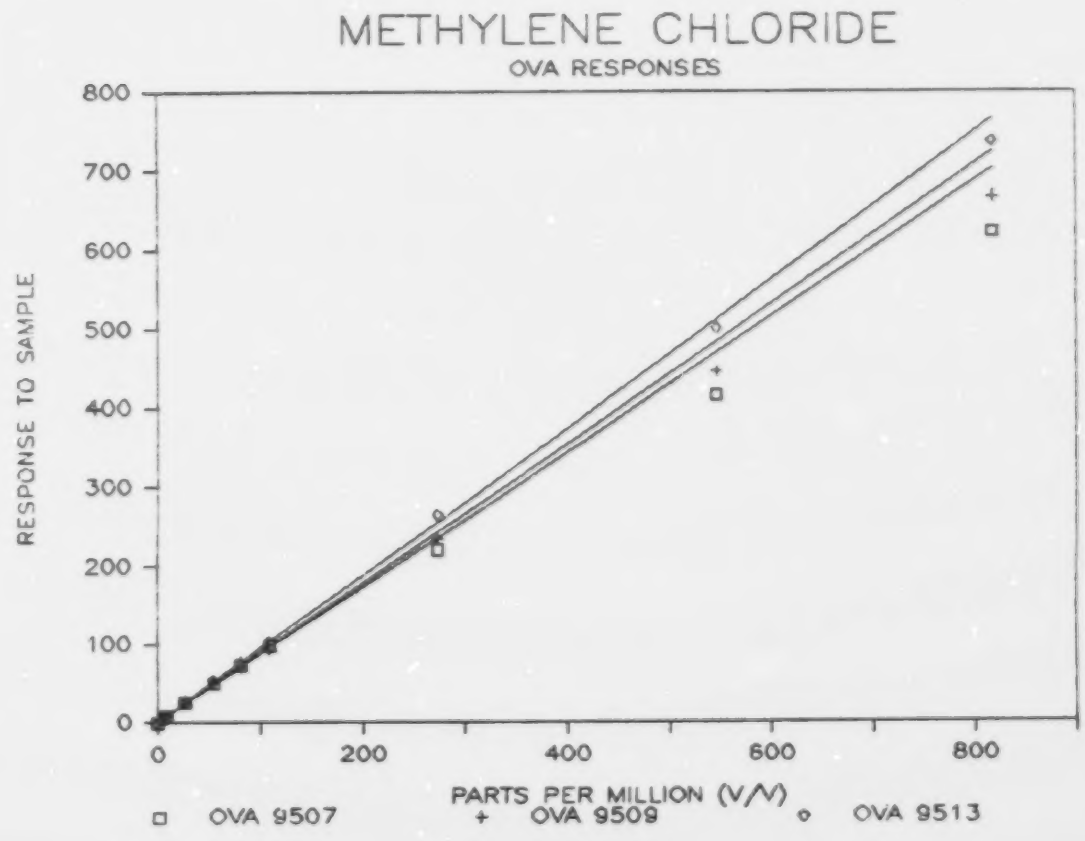
METHANE STANDARDS
##################

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	3.00	4.50	4.10	4.00	----
Yes	8.40	10.00	9.20	8.90	----
Yes	93.00	97.50	86.00	100.00	----
No	498.00	510.00	460.00	560.00	----
	SLOPE=	1.0429	0.9182	1.0760	
	INTERCEPT=	0.5728	0.6757	-0.0735	
	CORRELATION COEFFICIENT=	0.9999	0.9999	1.0000	

SAMPLE
############

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	0.00
Yes	0.40	27.90	5.5	5.65	5.65	5.20	5.60
Yes	0.60	26.20	8.7	9.10	9.25	8.45	9.05
Yes	2.00	27.90	27.3	25.00	25.00	27.00	25.00
Yes	3.50	24.40	54.7	50.00	50.00	53.00	50.00
Yes	5.00	23.30	81.9	73.00	71.00	76.50	72.50
Yes	7.00	24.40	109.4	97.00	94.00	102.00	97.00
No	20.00	27.90	273.4	220.00	235.00	265.00	220.00
No	35.00	24.40	547.2	415.00	445.00	500.00	415.00
No	50.00	23.30	818.6	620.00	665.00	735.00	610.00
		SLOPE=		0.8822	0.8558	0.9322	
		INTERCEPT=		0.8653	1.2983	0.5850	
		CORRELATION COEFFICIENT=		0.9999	0.9996	0.9998	
OVA RELATIVE RESPONSE FACTOR _____				0.8460	0.9312	0.8664	


METHANOL
OVA RESPONSES
RESPONSE TO SAMPLE
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
0
200
400
600
800
PARTS PER MILLION (V/V)
□ OVA 9507
+ OVA 9509
◇ OVA 9513


METHYLENE CHLORIDE
OVA RESPONSES
RESPONSE TO SAMPLE
800
700
600
500
400
300
200
100
0
0
200
400
600
800
PARTS PER MILLION (V/V)
□ OVA 9507
+ OVA 9509
◇ OVA 9513

METHYL METHACRYLATE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 100.1 DENSITY : 0.94 g/ml (20 C)
SAMPLE : J.T. BAKER, "BAKER" GRADE DATE : 12 DECEMBER, 1983

METHANE STANDARDS

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	9.75	9.95	10.00	----
Yes	93.00	90.50	94.00	100.00	----
No	490.00	485.00	495.00	625.00	----
	SLOPE=	0.9656	1.0037	1.0706	
	INTERCEPT=	0.7009	0.7234	0.4796	
	CORRELATION COEFFICIENT=	0.9999	0.9999	1.0000	

SAMPLE

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	0.70	29.50	5.4	3.50	4.10	3.90	---
Yes	1.50	21.10	16.3	8.90	10.20	9.60	---
Yes	3.00	25.30	27.2	13.50	17.00	16.00	---
Yes	5.20	21.10	54.4	26.00	33.00	31.00	---
Yes	10.00	21.10	106.6	53.00	66.50	63.00	---
Yes	15.00	21.10	163.2	83.00	100.00	98.00	---
Yes	25.00	21.10	272.0	130.00	165.00	170.00	---
No	50.00	21.10	544.1	265.00	360.00	400.00	
No	100.00	21.10	1088.2	625.00	755.00	870.00	
	SLOPE=			0.4822	0.6064	0.6197	
	INTERCEPT=			0.7144	0.3971	-1.2190	
	CORRELATION COEFFICIENT=			0.9994	1.0000	0.9994	
OVA RELATIVE RESPONSE FACTOR _____				0.4994	0.6041	0.5788	

METHYL ISOBUTYL KETONE - OVA RELATIVE RESPONSE FACTORS

SYNONYMS : MIBK
MOLECULAR WEIGHT : 100.2 DENSITY : 0.794 g/ml (25 C)
SAMPLE : J.T. BAKER, REAGENT GRADE DATE : 02 DECEMBER, 1983

METHANE STANDARDS

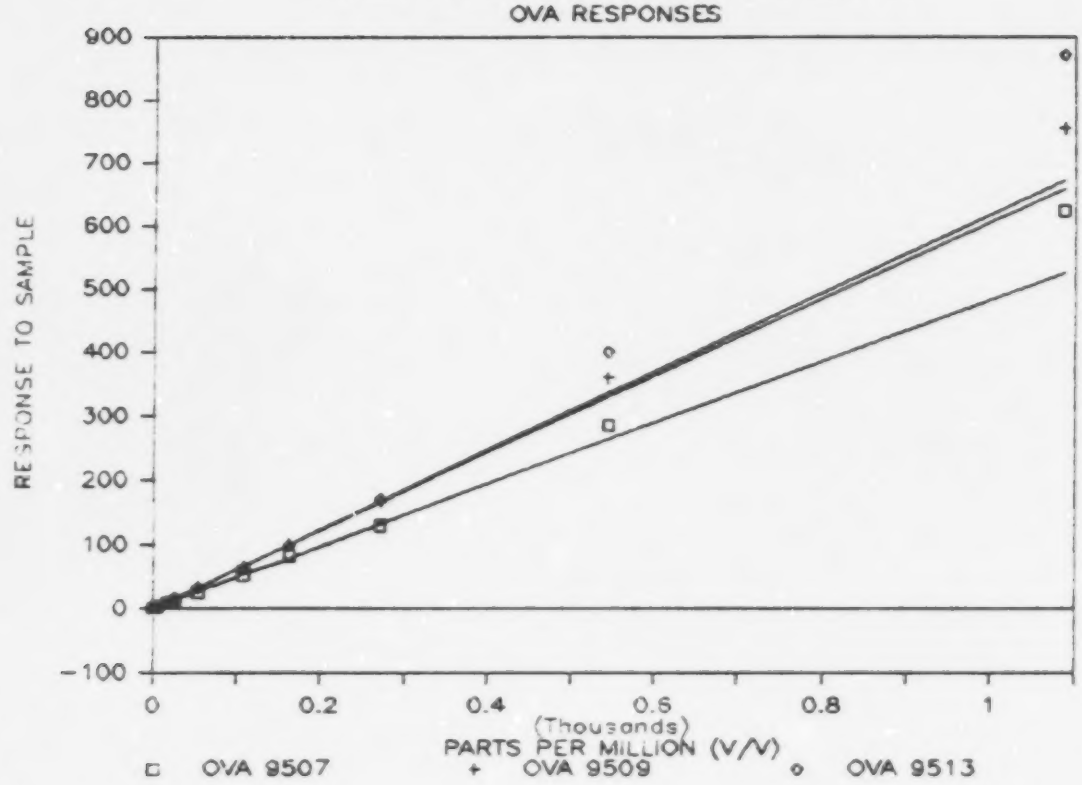
Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	6.00	10.00	8.70	----
Yes	93.00	88.00	110.00	97.00	----
No	490.00	480.00	605.00	590.00	----
	SLOPE=	0.9421	1.1825	1.0433	
	INTERCEPT=	0.4222	2.3328	-0.0304	
	CORRELATION COEFFICIENT=	1.0000	1.0000	1.0000	

SAMPLE

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	2.00	0.00	0.0	0.00	0.00	0.00	---
Yes	5.00	35.60	27.2	16.00	24.50	18.50	---
Yes	10.00	35.60	54.4	31.00	49.00	37.00	---
Yes	15.00	26.70	109.9	66.00	102.00	78.00	---
No	50.00	35.60	272.1	175.00	260.00	225.00	---
No	50.00	17.80	544.2	360.00	575.00	480.00	---
	SLOPE=			0.6853	0.9192	0.7176	
	INTERCEPT=			-0.6000	-0.4000	-0.3000	
	CORRELATION COEFFICIENT=			0.9994	0.9999	0.9996	
OVA RELATIVE RESPONSE FACTOR _____				0.6430	0.7774	0.6879	

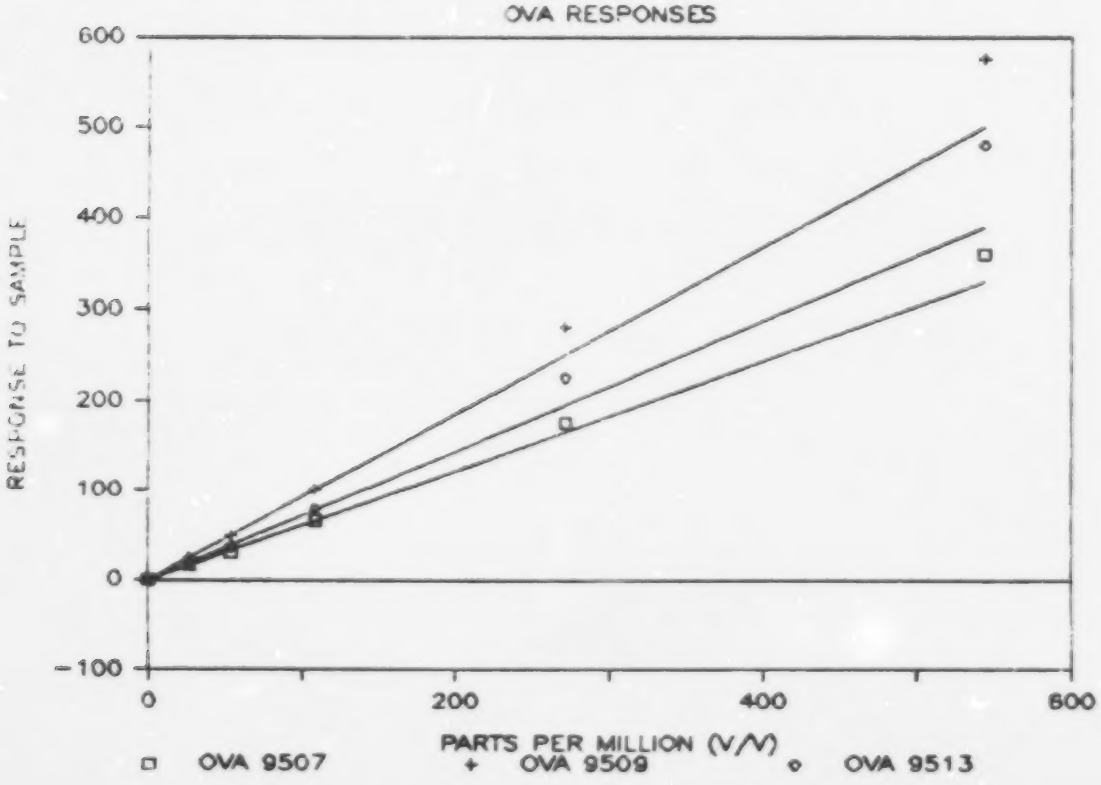
METHYL METHACRYLATE

OVA RESPONSES



MiBK

OVA RESPONSES



MORPHOLINE - DVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 87.1 DENSITY : 1.00 g/ml (20 C)
SAMPLE : KODAK, A.C.S. REAGENT GRADE DATE : 22 DECEMBER, 1983

METHANE STANDARDS
##################

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	10.00	9.70	8.70	----
Yes	93.00	95.00	93.00	97.00	----
No	498.00	490.00	560.00	570.00	----
	SLOPE=	1.0147	0.9938	1.0403	
	INTERCEPT=	0.7874	0.6442	-0.2304	
	CORRELATION COEFFICIENT=	0.9999	0.9999	1.0000	

SAMPLE
############

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	0.50	25.80	5.4	2.95	2.55	2.30	---
Yes	1.00	17.20	16.2	9.35	8.20	6.60	---
Yes	1.00	10.90	27.2	12.50	12.00	12.00	---
Yes	5.00	25.80	54.4	26.00	25.00	26.50	---
Yes	10.00	25.80	108.8	50.00	49.00	50.50	---
Yes	15.00	25.80	163.2	78.00	75.00	77.00	---
No	50.00	25.80	544.0	260.00	310.00	300.00	---
No	100.00	25.80	1088.0	650.00	785.00	745.00	
	SLOPE=			0.4789	0.4542	0.4729	
	INTERCEPT=			0.2520	0.0408	-0.3463	
	CORRELATION COEFFICIENT=			0.9995	0.9996	0.9998	
DVA RELATIVE RESPONSE FACTOR _____				0.4640	0.4568	0.4532	

NOTE : UP TO 5 MINUTES CONTINUOUS SAMPLING REQUIRED FOR EQUILIBRIUM TO BE ESTABLISHED AT LOWER CONCENTRATIONS, 3 MINUTES ALLOWED AT HIGHER CONCENTRATIONS.

PROPYLENE OXIDE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 58.1 DENSITY : 0.83 g/ml (20 C)
SAMPLE : J.T. BAKER, "BAKER" GRADE DATE : 1 FEBRUARY, 1984

METHANE STANDARDS

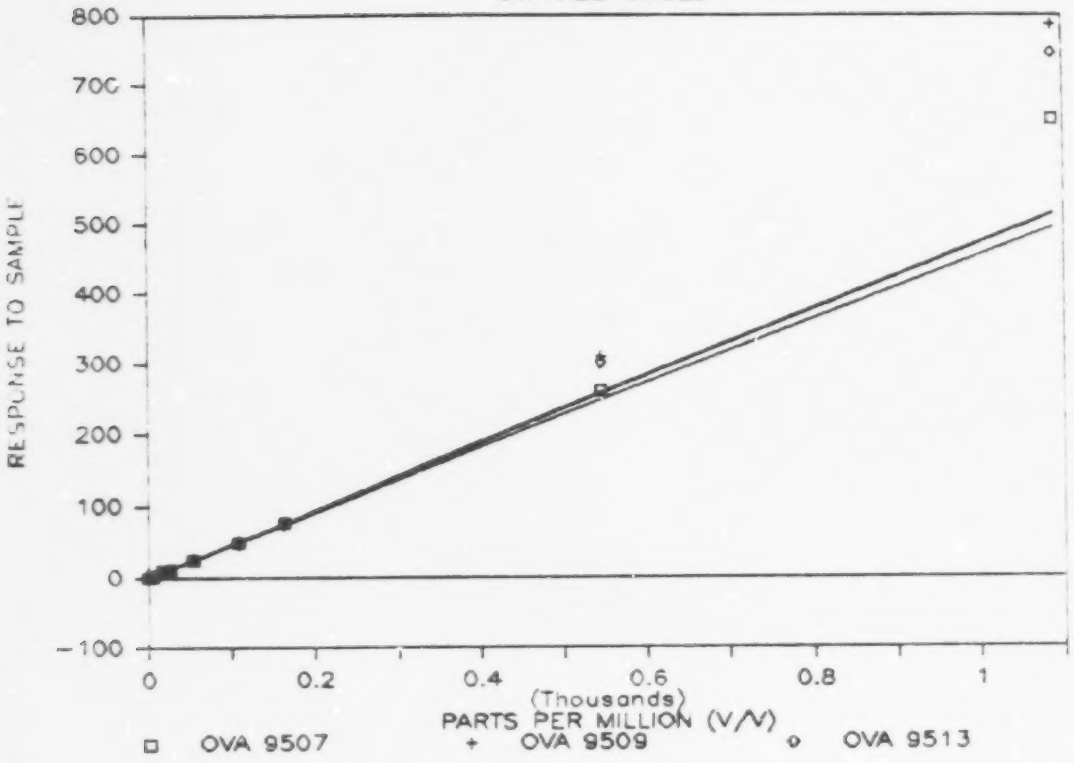
Used in Linear Regression	ppm (v/v)	Serial No. 9587 Instrument Reading	Serial No. 9589 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9587 Repeated
Yes	0.50	0.00	0.00	0.00	----
Yes	3.80	4.40	4.75	4.25	----
Yes	8.40	9.85	10.00	9.30	----
Yes	93.00	96.50	103.00	101.00	----
No	498.00	500.00	510.00	600.00	----
	SLOPE=	1.0325	1.1034	1.0850	
	INTERCEPT=	0.5325	0.4182	0.1813	
	CORRELATION COEFFICIENT=	0.9999	1.0000	1.0000	

SAMPLE

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9587 Instrument Reading	Serial No. 9589 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9587 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	0.40	25.70	5.4	3.75	4.20	3.40	3.75
Yes	0.80	25.70	10.9	6.40	7.95	6.45	6.40
Yes	2.40	25.70	32.6	18.00	23.00	20.50	18.00
Yes	4.00	21.40	65.3	36.00	46.00	40.00	36.00
Yes	7.00	24.90	98.2	54.50	68.00	60.00	54.50
Yes	9.00	24.10	130.4	73.00	91.50	80.00	73.00
No	20.00	25.70	271.8	152.00	175.00	175.00	145.00
No	42.00	25.70	567.6	300.00	360.00	380.00	295.00
No	75.00	24.10	1087.0	630.00	740.00	700.00	620.00
	SLOPE=			0.5562	0.6966	0.6124	
	INTERCEPT=			0.2780	0.2486	0.0567	
	CORRELATION COEFFICIENT=			0.9999	0.9999	1.0000	
OVA RELATIVE RESPONSE FACTOR _____				0.5387	0.6315	0.5644	

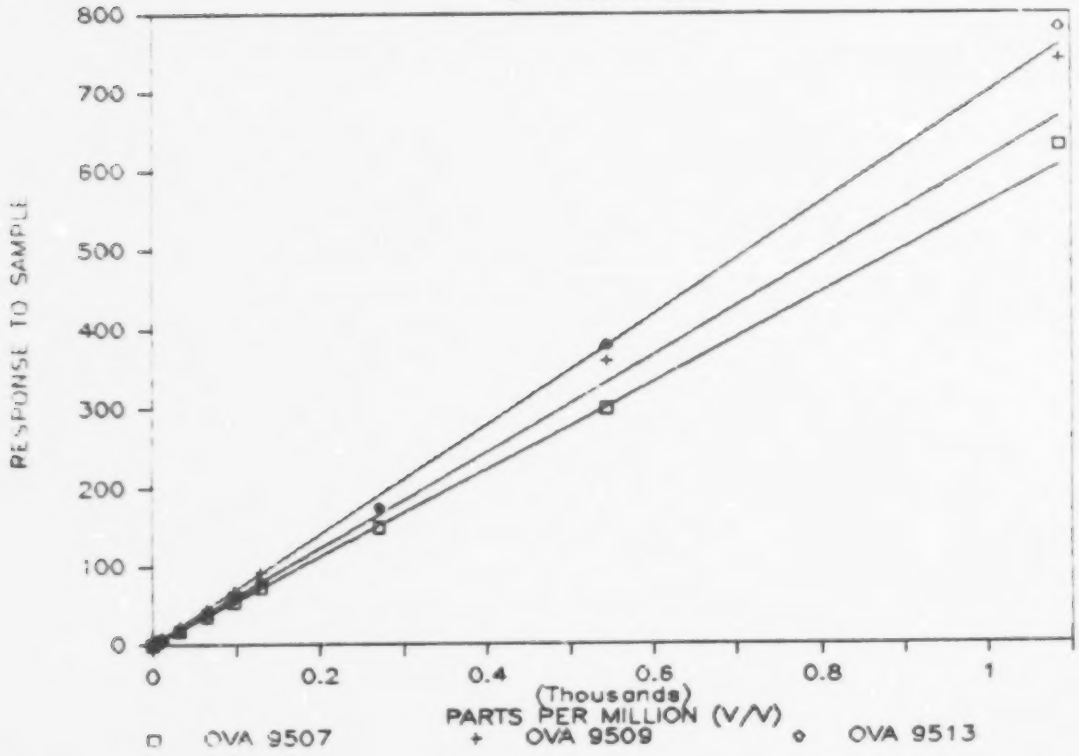
MORPHOLINE

OVA RESPONSES



PROPYLENE OXIDE

OVA RESPONSES



STYRENE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 104.2 DENSITY : 0.91 g/ml (20 C)
SAMPLE : J.T. BAKER, "BAKER" GRADE DATE : 16 DECEMBER, 1983

METHANE STANDARDS

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.42	9.70	9.60	8.60	----
Yes	93.00	95.50	97.00	100.00	----
Yes	490.00	495.00	530.00	610.00	----
		SLOPE=	0.9910	1.0644	1.2311
		INTERCEPT=	1.4304	-0.3459	-4.0260
		CORRELATION COEFFICIENT=	1.0000	1.0000	0.9997

SAMPLE

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	0.00	31.40	5.4	5.40	6.30	5.30	---
Yes	1.00	19.60	10.9	10.00	12.00	11.00	---
Yes	4.00	31.40	27.2	24.00	29.00	28.00	---
Yes	5.00	19.60	54.5	50.00	59.00	50.00	---
Yes	10.00	19.60	100.9	100.00	120.00	125.00	---
Yes	15.00	19.60	163.4	150.00	185.00	200.00	---
No	25.00	19.60	272.4	260.00	325.00	350.00	---
No	50.00	19.60	544.7	600.00	835.00	890.00	
			SLOPE=	0.9101	1.1261	1.2159	
			INTERCEPT=	-0.0932	-0.8222	-3.2981	
			CORRELATION COEFFICIENT=	1.0000	0.9990	0.9980	
OVA RELATIVE RESPONSE FACTOR _____				0.9250	1.0500	0.9877	

TETRACHLORDETHYLENE - OVA RELATIVE RESPONSE FACTORS

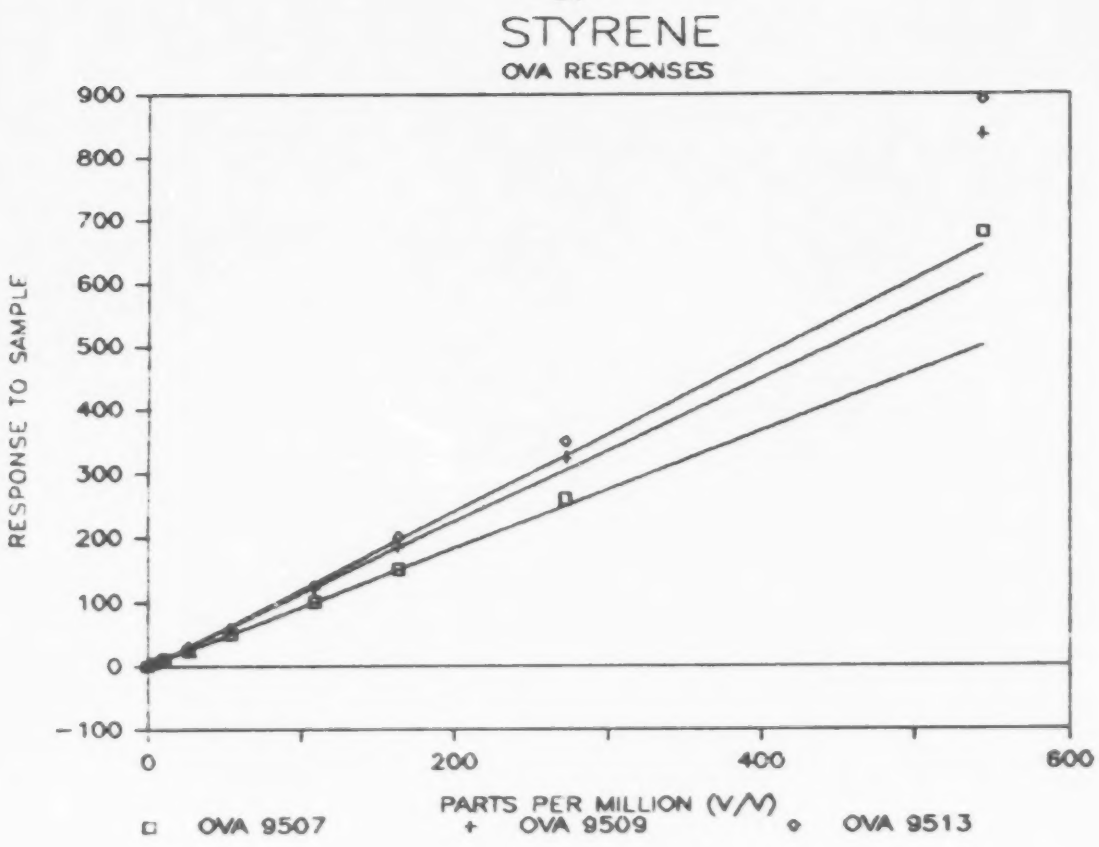
SYNONYM: PERCHLORDETHYLENE
MOLECULAR WEIGHT : 165.8 DENSITY : 1.613 g/ml (25 C)
SAMPLE : J.T. BAKER, REAGENT GRADE DATE : 01 DECEMBER, 1983

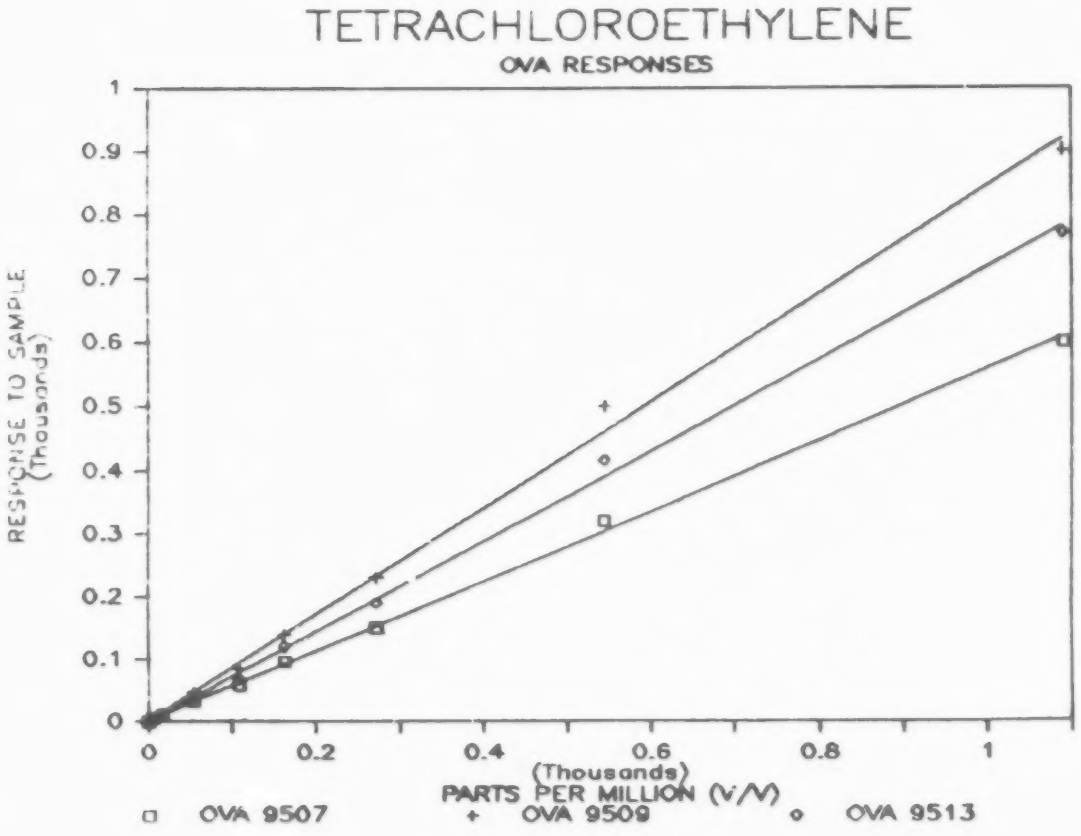
METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	9.90	10.00	9.20	----
Yes	93.00	90.00	112.00	100.00	----
Yes	490.00	490.00	615.00	600.00	----
	SLOPE=	0.9831	1.2369	1.2097	
	INTERCEPT=	0.1630	-1.6007	-3.9740	
	CORRELATION COEFFICIENT=	1.0000	1.0000	0.9998	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	1.00	43.70	5.4	4.70	4.90	4.10	---
Yes	1.00	14.60	16.3	10.00	13.00	10.00	---
Yes	10.00	43.70	54.4	33.00	47.00	38.00	---
Yes	10.00	21.80	109.1	58.00	85.00	68.00	---
Yes	25.00	36.40	163.4	96.00	140.00	120.00	---
Yes	25.00	21.80	272.8	150.00	230.00	190.00	---
Yes	100.00	43.70	544.3	320.00	500.00	415.00	---
Yes	100.00	21.80	1091.1	600.00	900.00	770.00	---
	SLOPE=			0.5543	0.8393	0.7156	
	INTERCEPT=			2.3078	2.8578	0.8174	
	CORRELATION COEFFICIENT=			0.9994	0.9986	0.9991	
OVA RELATIVE RESPONSE FACTOR _____				0.5638	0.6785	0.5915	


STYRENE
OVA RESPONSES
RESPONSE TO SAMPLE
900
800
700
600
500
400
300
200
100
0
-100
0
200
400
600
PARTS PER MILLION (V/V)
□ OVA 9507
+ OVA 9509
◇ OVA 9513


TETRACHLOROETHYLENE
OVA RESPONSES
RESPONSE TO SAMPLE
(Thousands)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
(Thousands)
PARTS PER MILLION (V/V)
□ OVA 9507
+ OVA 9509
◇ OVA 9513

TOLUENE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 92.1 DENSITY : 0.87 g/ml (20 C)
SAMPLE : J.T. BAKER, REAGENT GRADE DATE : 29 NOVEMBER, 1983

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	5.40	7.95	9.60	8.20	----
Yes	93.00	85.50	122.00	94.00	----
Yes	498.00	478.00	595.00	500.00	----
	SLOPE=	0.9445	1.1963	1.1709	
	INTERCEPT=	-0.6753	-2.9883	-4.9857	
	CORRELATION COEFFICIENT=	1.0000	0.9999	0.9997	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	----
Yes	1.00	46.20	5.0	5.10	7.10	5.40	----
Yes	3.97	14.92	15.3	14.00	21.00	16.00	----
Yes	5.00	28.90	40.0	40.00	58.00	47.00	----
Yes	10.00	30.80	75.0	76.00	110.00	89.00	----
Yes	10.00	15.40	150.0	160.00	230.00	200.00	----
Yes	25.00	23.10	250.0	250.00	390.00	340.00	----
No	76.00	35.10	500.1	600.00	890.00	790.00	----
No	100.00	30.80	749.9	1010.00	>1000.00	>1000.00	----
	SLOPE=			1.0155	1.5617	1.3673	
	INTERCEPT=			0.2724	-2.7551	-4.8569	
	CORRELATION COEFFICIENT=			0.9993	0.9998	0.9993	
OVA RELATIVE RESPONSE FACTOR _____				1.0751	1.3033	1.1676	

1,1,1-TRICHLORDETHANE - OVA RELATIVE RESPONSE FACTORS

SYNONYMS : METHYL CHLOROFORM, CHLOROTHENE
MOLECULAR WEIGHT : 133.4 DENSITY : 1.34 g/al (20 C)
SAMPLE : SARGENT-WELCH, TECHNICAL GRADE (See Note) DATE : 13 JANUARY, 1984

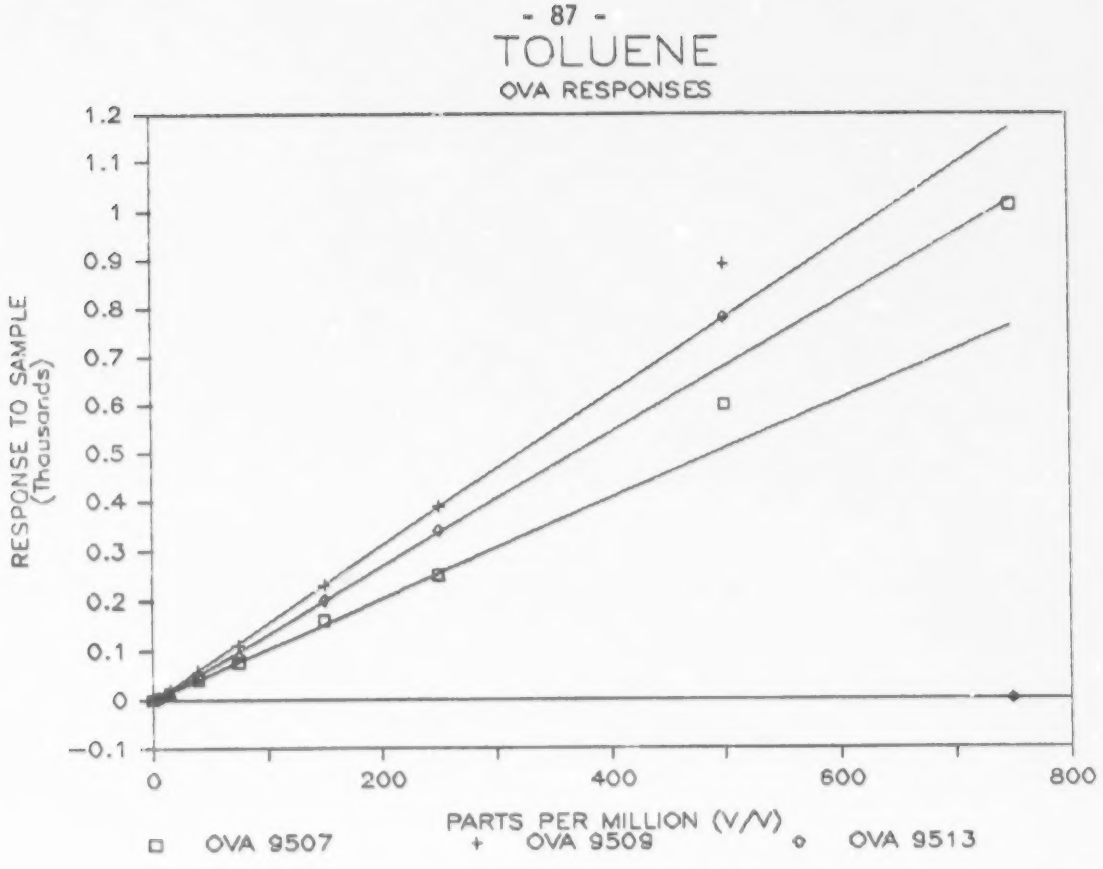
METHANE STANDARDS
****

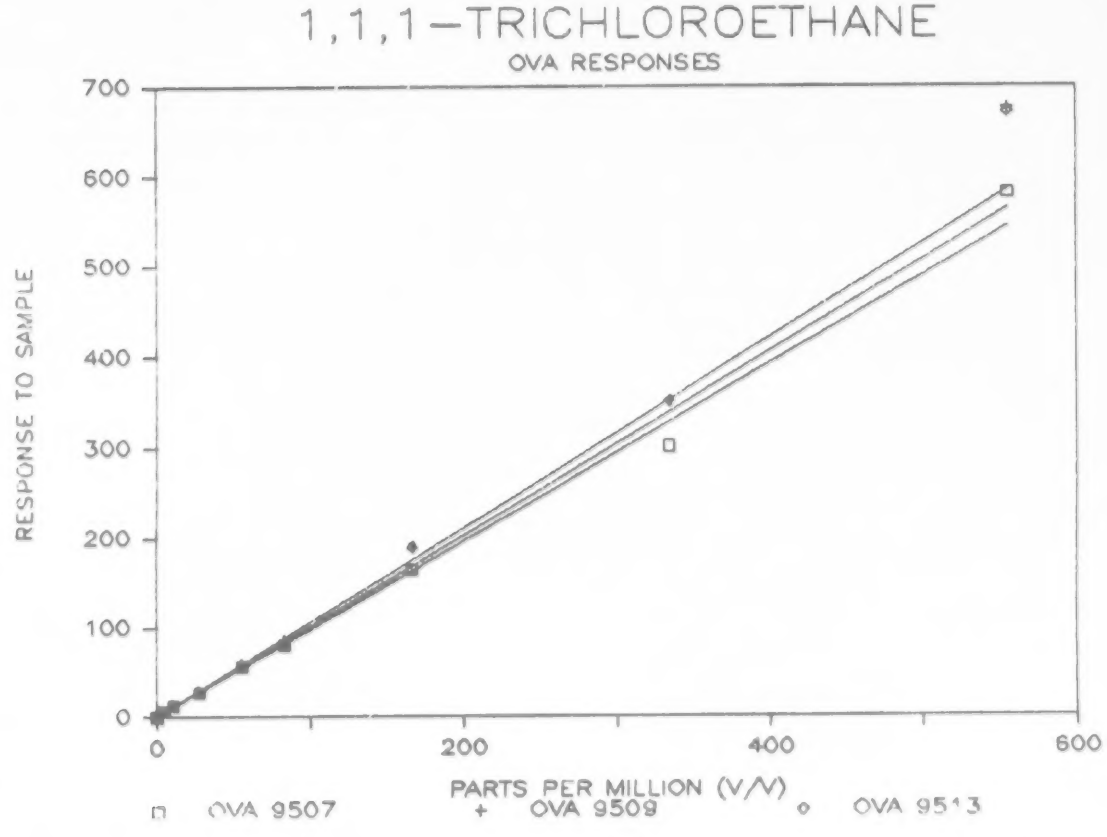
Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	3.80	4.40	4.10	3.70	----
Yes	6.40	9.60	9.20	8.20	----
Yes	93.00	97.50	94.50	97.00	----
No	498.00	525.00	540.00	590.00	----
	SLOPE=	1.0439	1.0132	1.0457	
	INTERCEPT=	0.4721	0.3019	-0.2766	
	CORRELATION COEFFICIENT=	1.0000	1.0000	1.0000	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.30	0.00	0.0	0.00	0.00	0.00	---
Yes	0.80	35.20	5.6	6.30	6.45	5.50	---
Yes	1.00	22.00	11.2	12.50	13.00	12.50	---
Yes	4.00	35.32	27.8	27.00	29.50	28.00	---
Yes	6.00	26.50	55.6	57.00	60.00	57.00	---
Yes	10.00	29.50	83.3	91.00	87.50	84.50	---
No	15.00	22.10	166.7	165.00	190.00	190.00	---
No	40.00	29.40	334.1	300.00	350.00	350.00	---
No	50.00	22.10	555.7	580.00	675.00	670.00	
		SLOPE=		0.9765	1.0508	1.0142	
		INTERCEPT=		0.7763	0.6148	0.2417	
		CORRELATION COEFFICIENT=		0.9993	0.9998	0.9999	
		OVA RELATIVE RESPONSE FACTOR _____		0.9355	1.0371	0.9699	

NOTE : "TYPICAL" PURITY 94.5 % MINIMUM. HOWEVER, GC ANALYSIS REVEALED
LARGE NUMBER OF COMPONENTS AND SUGGESTS PROPORTION OF 1,1,1-TRICLOROETHANE
IS LOWER THAN TYPICAL VALUE.


TOLUENE
OVA RESPONSES
RESPONSE TO SAMPLE (Thousands)
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
−0.1
0
200
400
600
800
PARTS PER MILLION (V/V)
□ OVA 9507
+ OVA 9509
◇ OVA 9513


1,1,1—TRICHLOROETHANE
OVA RESPONSES
RESPONSE TO SAMPLE
700
600
500
400
300
200
100
0
0
200
400
600
PARTS PER MILLION (V/V)
□ OVA 9507
+ OVA 9509
◇ OVA 9513

TURPENTINE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : TAKEN AS 136 DENSITY : 0.85 g/ml (Measured 25 C)
SAMPLE : RECOCHEM DATE : 26 JANUARY, 1984

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	3.80	4.80	4.30	4.25	----
Yes	8.40	10.00	9.50	9.00	----
Yes	93.00	97.50	89.50	99.50	----
No	498.00	500.00	500.00	585.00	----
	SLOPE=	1.0417	0.9557	1.0692	
	INTERCEPT=	0.6775	0.6903	0.0686	
	CORRELATION COEFFICIENT=	0.9999	0.9999	1.0000	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	1.00	20.10	5.4	6.20	6.80	5.00	---
Yes	2.50	35.10	10.9	10.00	11.00	11.00	---
Yes	4.00	22.50	27.2	26.50	30.00	29.00	---
Yes	10.00	26.10	54.4	51.00	57.00	56.00	---
Yes	15.00	28.10	81.6	78.00	86.00	84.00	---
No	25.00	28.10	136.0	130.00	150.00	160.00	---
No	50.00	23.40	326.5	340.00	420.00	425.00	---
No	100.00	28.10	543.8	660.00	775.00	805.00	---
	SLOPE=			0.9479	1.0487	1.0290	
	INTERCEPT=			0.2678	0.4383	0.1913	
	CORRELATION COEFFICIENT=			0.9998	0.9998	0.9999	
OVA RELATIVE RESPONSE FACTOR _____				0.9899	1.0973	0.9625	

VINYL ACETATE - OVA RELATIVE RESPONSE FACTORS

MOLECULAR WEIGHT : 86.1 DENSITY : 0.93 g/ml (20 C)
SAMPLE : KODAK, PRACTICAL GRADE DATE : 19 DECEMBER, 1983

METHANE STANDARDS
****

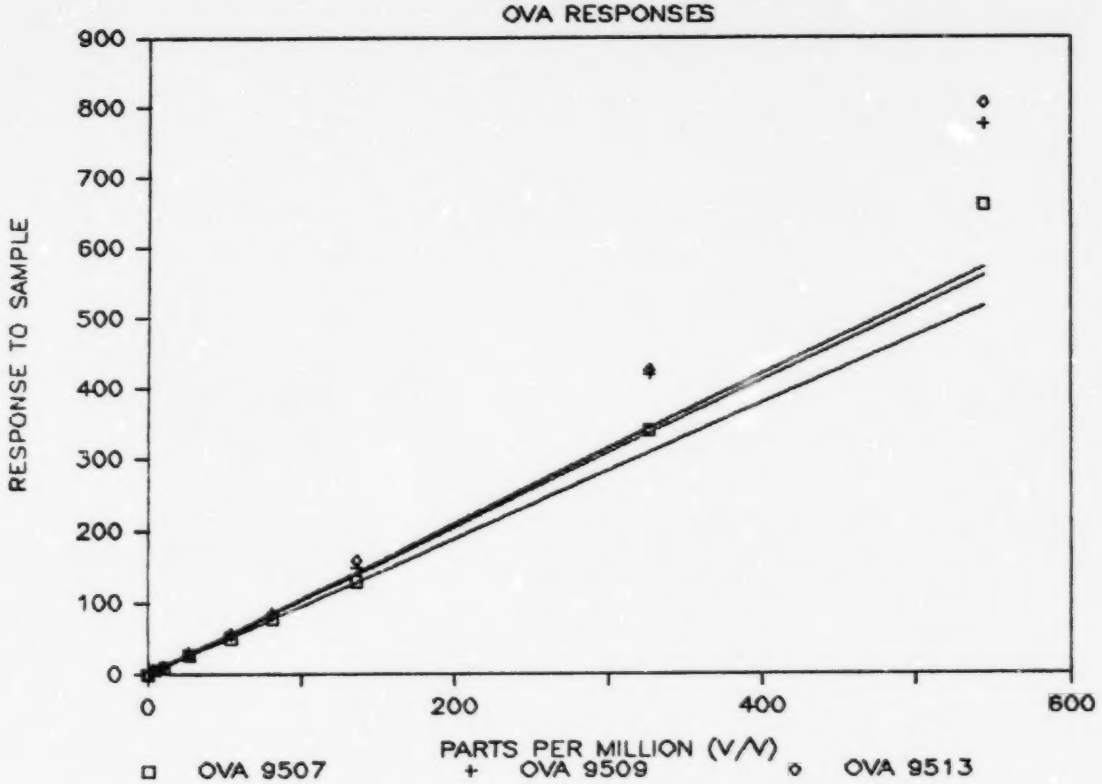
Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	10.00	10.00	9.10	----
Yes	93.00	100.00	100.00	110.00	----
Yes	498.00	525.00	550.00	630.00	----
	SLOPE=	1.0526	1.1047	1.2690	
	INTERCEPT=	1.0209	-0.5435	-2.8786	
	CORRELATION COEFFICIENT=	1.0000	1.0000	0.9999	

SAMPLE
****

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	0.50	24.30	5.4	3.25	3.60	2.90	---
Yes	1.00	24.30	10.9	6.10	7.10	5.55	---
Yes	2.00	24.30	21.7	10.50	12.50	11.00	---
Yes	5.00	24.30	54.3	26.50	32.50	29.00	---
Yes	10.00	24.30	108.7	50.00	61.00	58.00	---
Yes	15.00	24.30	163.0	80.00	96.00	93.00	---
Yes	20.00	24.30	217.4	100.00	120.00	120.00	---
Yes	50.00	24.30	543.4	245.00	315.00	320.00	---
Yes	100.00	24.30	1086.8	460.00	600.00	610.00	---
		SLOPE=		0.4415	0.5553	0.5666	
		INTERCEPT=		2.4853	1.9520	-0.3670	
		CORRELATION COEFFICIENT=		0.9999	0.9997	0.9997	
OVA RELATIVE RESPONSE FACTOR _____				0.4195	0.5027	0.4465	

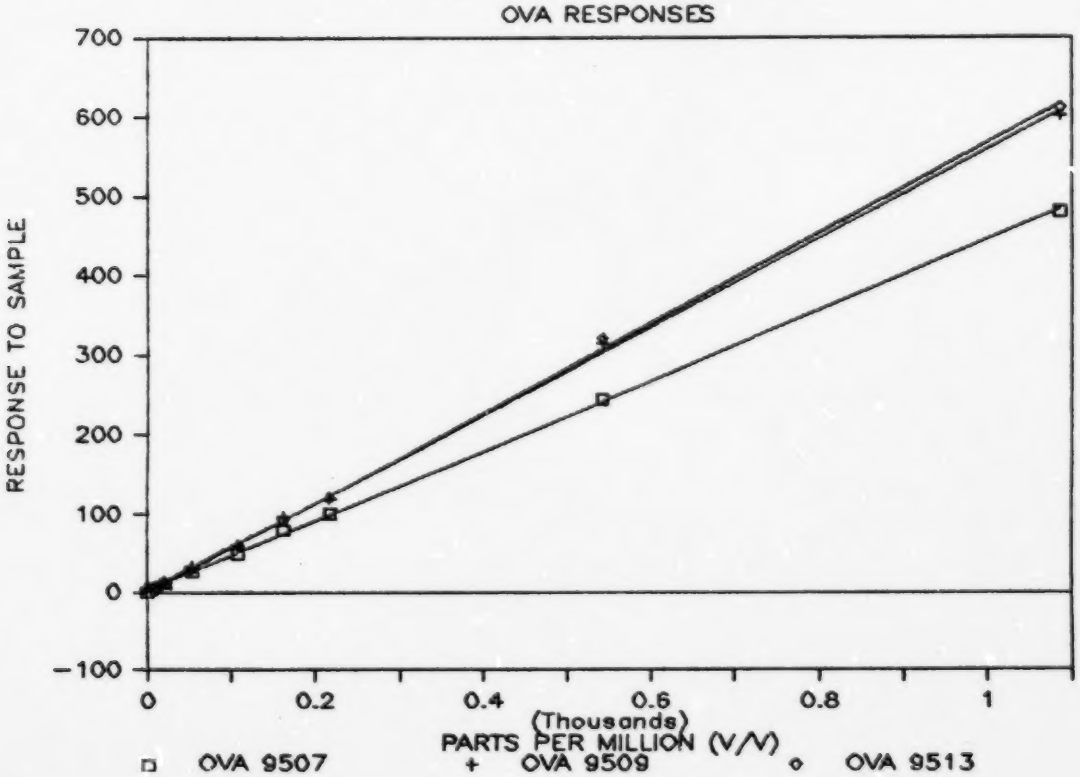
TURPENTINE

OVA RESPONSES



VINYL ACETATE

OVA RESPONSES



VINYL CHLORIDE - OVA RELATIVE RESPONSE FACTORS

SYNONYMS : CHLOROETHENE, CHLOROETHYLENE
MOLECULAR WEIGHT : 62.5 DENSITY : 0.9106 g/ml (20 C)
SAMPLE : SCOTT, 1000 ppm PLUS OR MINUS 2% IN AIR DATE : 09 DECEMBER, 1983

METHANE STANDARDS
****

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	8.40	9.40	9.70	8.80	----
Yes	8.40	9.40	9.60	8.80	----
Yes	93.00	90.00	95.00	97.50	----
	SLOPE=		0.9594	1.0145	1.0484
	INTERCEPT=		0.8656	0.7283	-0.0044
	CORRELATION COEFFICIENT=		0.9999	0.9999	1.0000

SAMPLE
****

LR	Sample (ml)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	125.00	25.00	5.0	2.50	2.75	2.25	---
Yes	250.00	25.00	10.0	4.80	5.10	4.50	---
Yes	375.00	25.00	15.0	6.85	7.30	6.55	---
Yes	625.00	25.00	25.0	10.50	11.50	11.00	---
Yes	1250.00	25.00	50.0	22.50	24.00	24.00	---
Yes	1875.00	25.00	75.0	33.00	36.00	36.00	---
Yes	2500.00	25.00	100.0	45.00	48.00	49.00	---
	SLOPE=			0.4456	0.4784	0.4908	
	INTERCEPT=			0.0424	0.0877	-0.5138	
	CORRELATION COEFFICIENT=			0.9997	0.9999	0.9997	
OVA RELATIVE RESPONSE FACTOR _____				0.4646	0.4716	0.4681	

M-XYLENE - OVA RELATIVE RESPONSE FACTORS

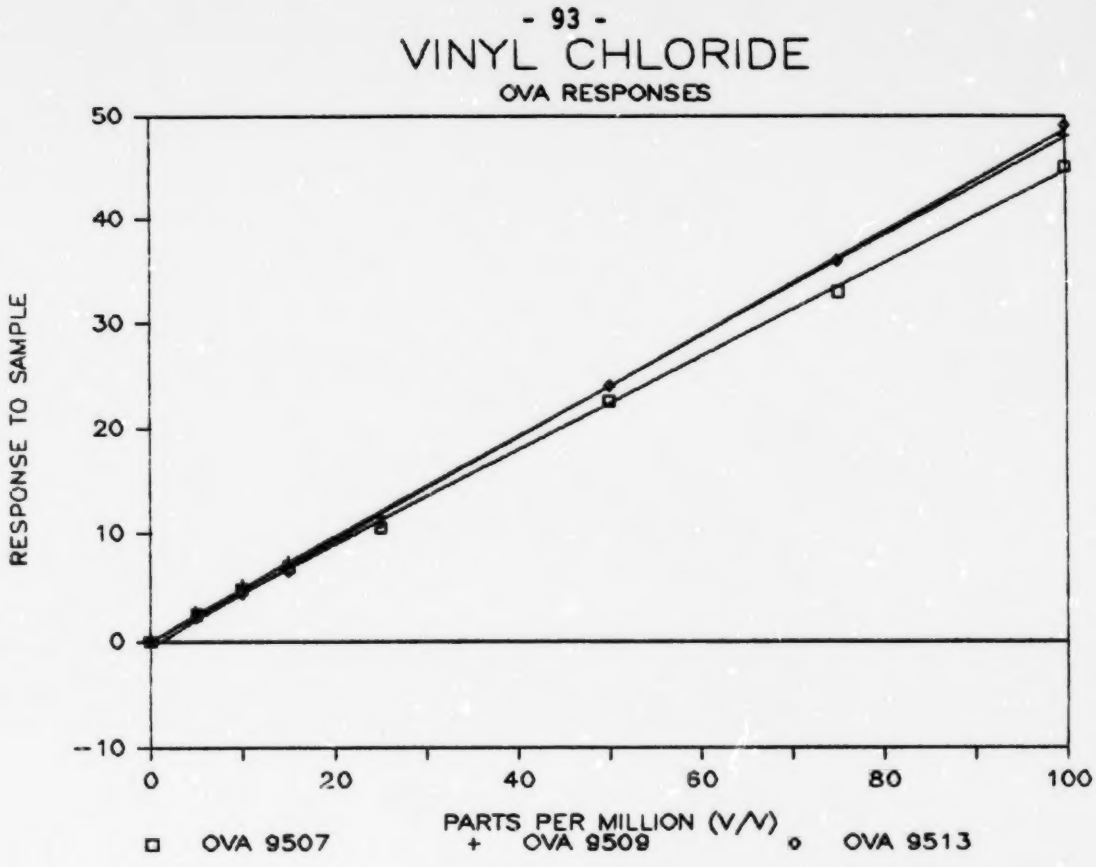
SYNONYM : 1,3-DIMETHYLBENZENE
MOLECULAR WEIGHT : 106.2 DENSITY : 0.86 g/ml (20 C)
SAMPLE : J.T. BAKER, "BAKER" GRADE DATE : 20,21 DECEMBER, 1983

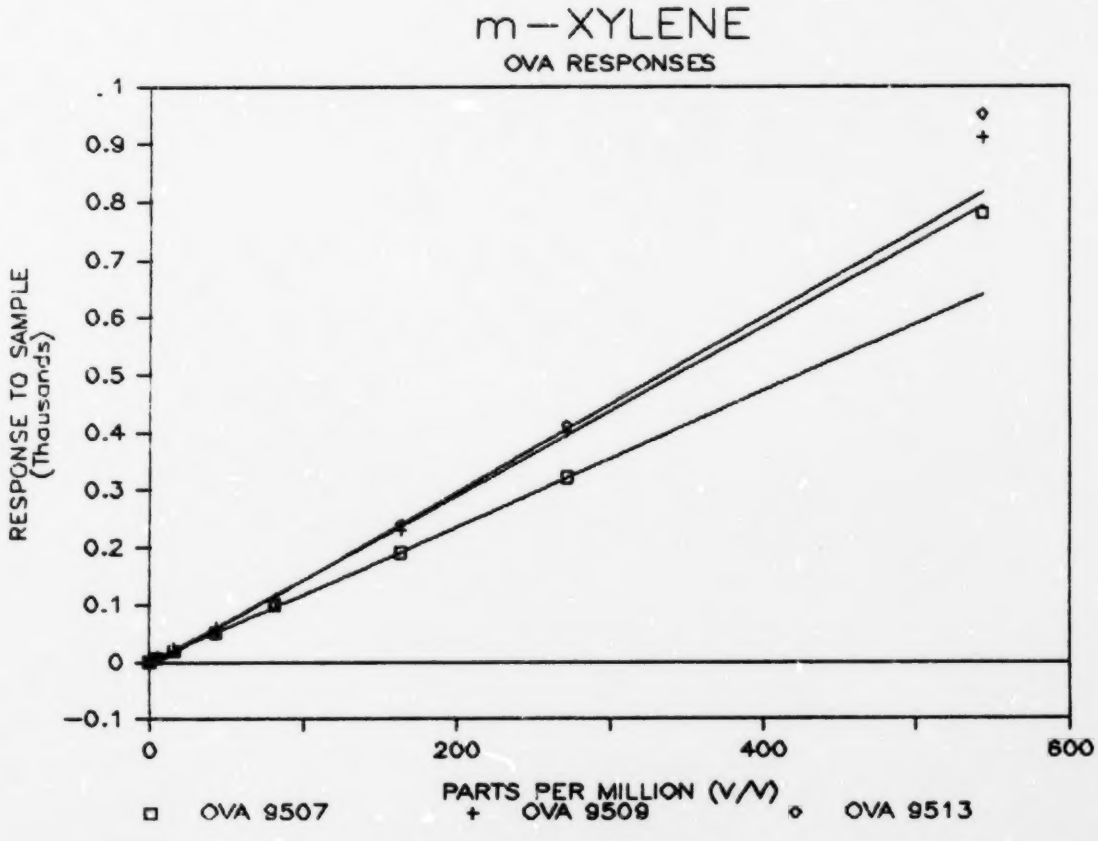
METHANE STANDARDS

Used in Linear Regression	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.00	0.00	----
Yes	9.49	10.00	10.00	8.00	----
Yes	93.00	100.00	101.00	105.00	----
Yes	498.00	535.00	555.00	625.00	----
	SLOPE=	1.0734	1.1148	1.2605	
	INTERCEPT=	0.3951	-0.5554	-4.1841	
	CORRELATION COEFFICIENT=	1.0000	1.0000	0.9998	

SAMPLE

LR	Sample (ul)	Volume Air (l)	ppm (v/v)	Serial No. 9507 Instrument Reading	Serial No. 9509 Instrument Reading	Serial No. 9513 Instrument Reading	Serial No. 9507 Repeated
Yes	0.00	0.00	0.0	0.00	0.00	0.00	---
Yes	0.70	25.50	5.4	7.20	8.00	6.00	---
Yes	2.00	24.20	16.4	20.00	23.50	20.00	---
Yes	5.00	22.70	43.6	51.00	60.00	52.00	---
Yes	10.00	24.20	81.8	100.00	110.00	100.00	---
Yes	20.00	24.20	163.6	190.00	230.00	240.00	---
Yes	25.00	18.20	272.0	320.00	400.00	410.00	---
No	50.00	18.20	543.9	780.00	910.00	950.00	---
		SLOPE=		1.1716	1.4603	1.5161	
		INTERCEPT=		0.7703	-2.7979	-7.9471	
		CORRELATION COEFFICIENT=		0.9999	0.9995	0.9985	
OVA RELATIVE RESPONSE FACTOR _____				1.0914	1.3099	1.2020	


VINYL CHLORIDE
OVA RESPONSES
RESPONSE TO SAMPLE
50
40
30
20
10
0
-10
0
20
40
60
80
100
PARTS PER MILLION (V/V)
□ OVA 9507
+ OVA 9509
◇ OVA 9513


m-XYLENE
OVA RESPONSES
RESPONSE TO SAMPLE
(Thousands)
.1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
200
400
600
PARTS PER MILLION (V/V)
□ OVA 9507
+ OVA 9509
◇ OVA 9513

APPENDIX B

HNU PI 101 CALIBRATION DATA FOR PRIORITY LIST SUBSTANCES

ACETONE - SPAN = 9.8 HNU CALIBRATION DATA

SAMPLE : J.T. BAKER, REAGENT GRADE
DATE : 06 DECEMBER, 1983
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	9.9	10.3	10.4	11.2	
101	86	88	94	95	
509	330	310	360	380	
SAMPLES					
10.9	6.2	6.4	6.2	7.0	6.2 (t=8)
21.8	10.7	11.8	11.2	12.4	10.6 (t=5)
54.5	24	27	26	27	24 (t=8)
109	46	52	49	51	45 (t=8)
272	99	112	108	109	97 (t=8)
545	171	178	190	189	168 (t=10)
1089	280	270	305	305	280 (t=8)
1634	335	315	360	380	330 (t=8)

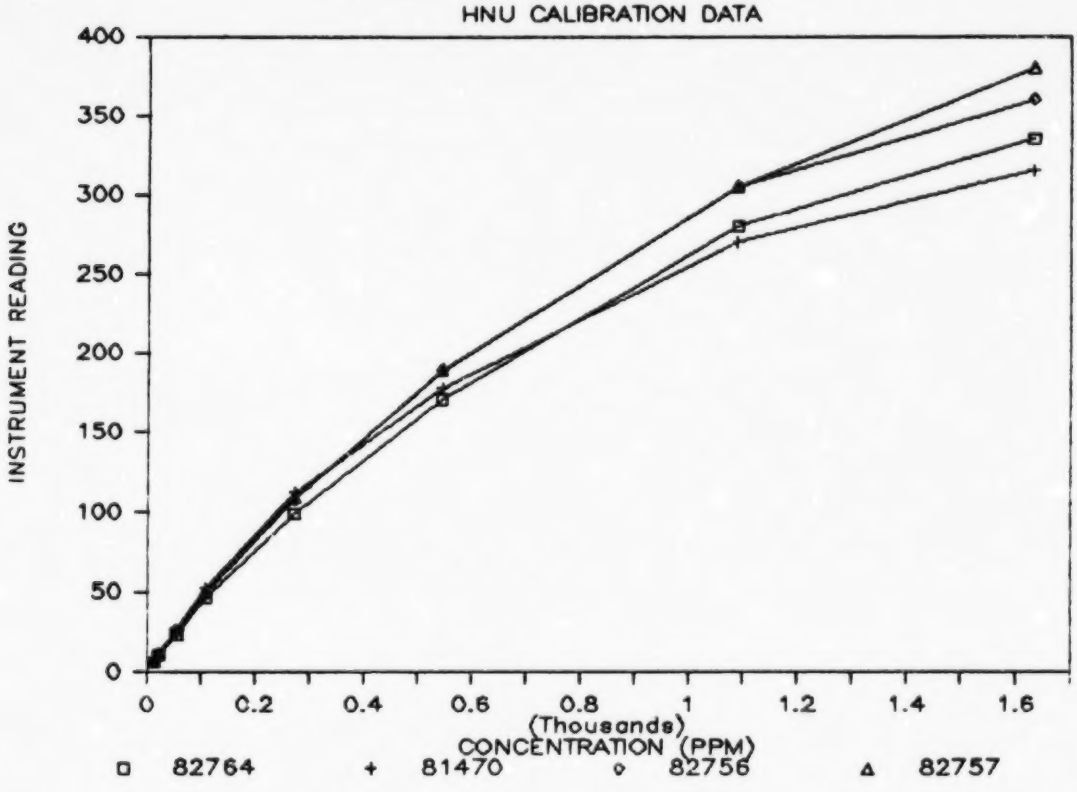
ACETONE - SPAN = 6.2 HNU CALIBRATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	128	135	140	143	
508	495	470	545	570	
SAMPLES					
10.9	9.2	---	---	10.4	
22	16.0	---	16.9	18.7	
55	36	41	---	41	
109	68	79	---	76	
272	148	174	163	164	
545	260	280	290	290	
1089	410	410	455	450	
1634	495	475	545	560	

NOTE : READINGS WERE FIRST TAKEN AT SPAN 9.8 THEN SPAN ADJUSTED TO 6.2 WITH SAMPLE BAG STILL ATTACHED.

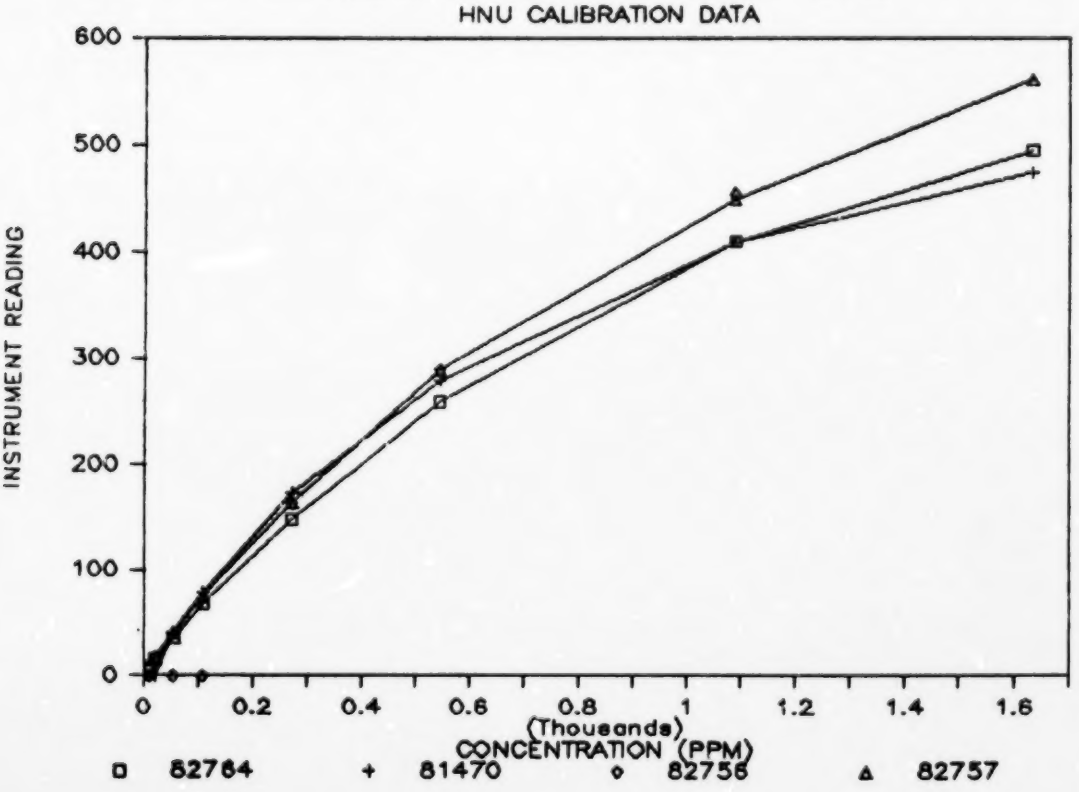
ACETONE — SPAN 9.8

HNU CALIBRATION DATA



ACETONE — SPAN 6.2

HNU CALIBRATION DATA



BENZENE - SPAN=9.8 HNU CALIBRATION DATA

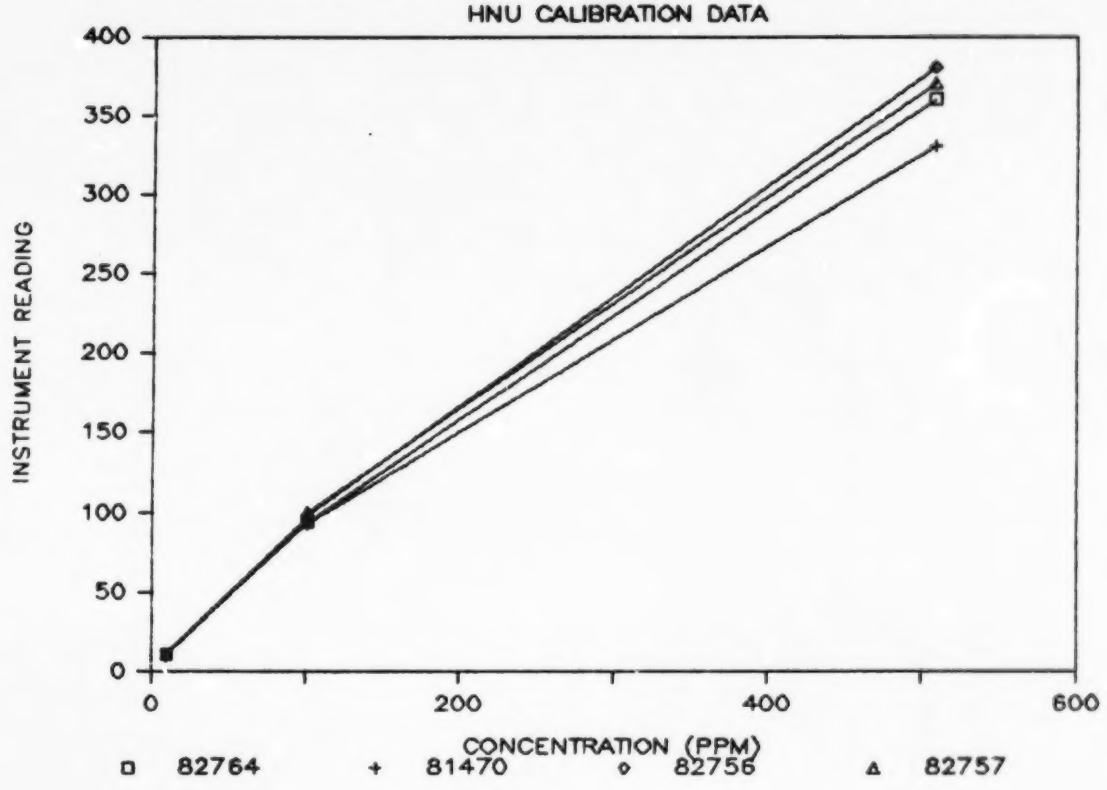
SAMPLE : MATHESON - 9.99, 101, AND 508 ppm IN AIR
DATE : 24,25 NOVEMBER, 1983

BENZENE PREMIXED STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764	
10.0	10.9	10.3	10.8	12.0		
10.0	11.0	11.0	10.6	11.5		
101	94	97	96	96		
101	94	94	95	96		
101	94	93	98	100		
508	360	330	380	370		
508	360	340	370	370		
SAMPLES						
5.0	5.4	5.2	5.0	5.8	4.9 (t=10)	
15.0	15.2	15.7	14.7	15.8	12.5 (t=7)	
39	37	38	36	38	35 (t=7)	
51	50	48	50	51	49 (t=4)	46 (t=7)
152	132	137	134	131	116 (t=6)	
203	174	177	182	172	169 (t=4)	152 (t=7)
355	270	270	280	270	260 (t=3)	240 (t=7)

NOTE : SAMPLES PREPARED IN 5 LITRE TEDLAR BAG BY BLENDING OR DILUTING MATHESON STANDARDS IN ACCURATE VOLUME RATIOS.

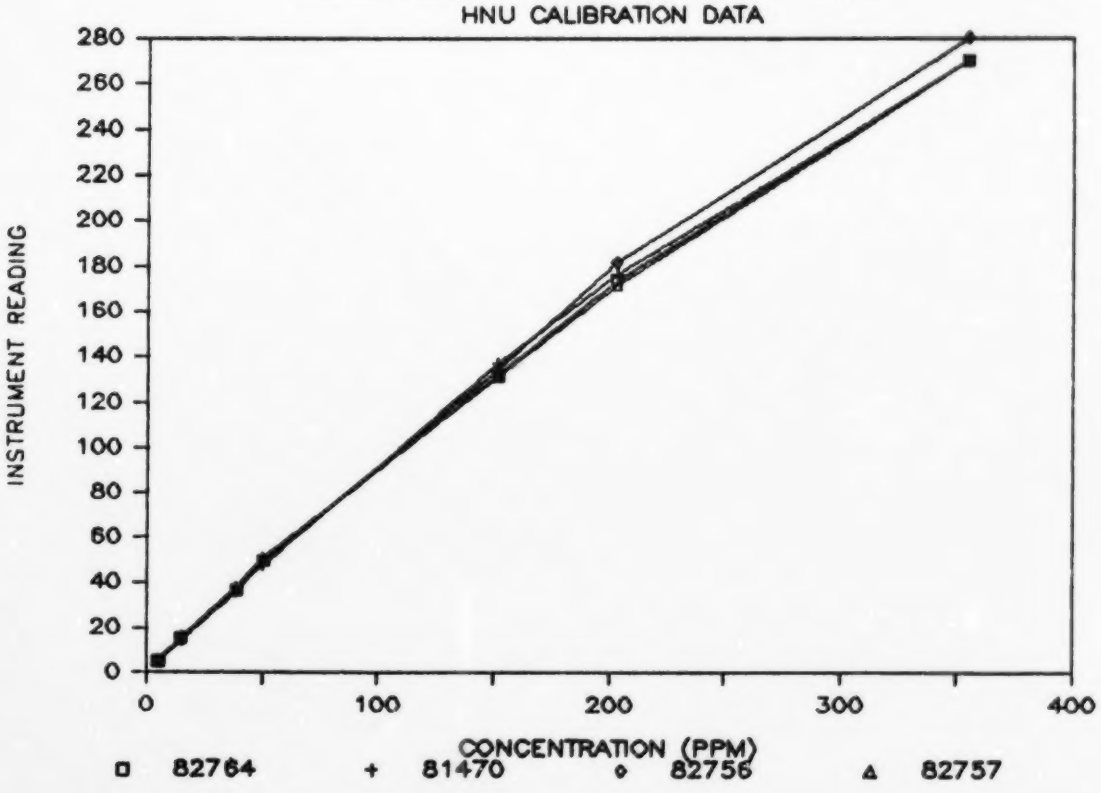
BENZENE — SPAN 9.8 — PREMIX

HNU CALIBRATION DATA



BENZENE — SPAN 9.8

HNU CALIBRATION DATA



1-BUTANOL - SPAN = 9.8 HNU CALIBRATION DATA

SYNONYMS : n-BUTANOL, n-BUTYL ALCOHOL
SAMPLE : J.T. BAKER, PHOTREX REAGENT GRADE
DATE : 15 DECEMBER, 1983
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	11.0	11.8	10.2	11.7	
10.0	11.1	11.8	10.0	13.0	
101	99	109	91	106	
SAMPLES					
10.9	1.5	1.4	1.2	1.6	1.4 (t=23)
27	2.7	2.6	2.5	3.1	---
109	9.7	9.8	9.4	12.4	9.2 (t=18)
218	16.4	17.1	16.2	23	16.3 (t=14)
436	31	33	31	40	31 (t=10)
653	40	43	40	52	40 (t=9)
1089	55	60	55	72	55 (t=10)

NOTES : 3.5 HR BETWEEN 10 PPM BENZENE READINGS ON 82757.

VERY SLOW RESPONSE AT LOWER CONCENTRATIONS.

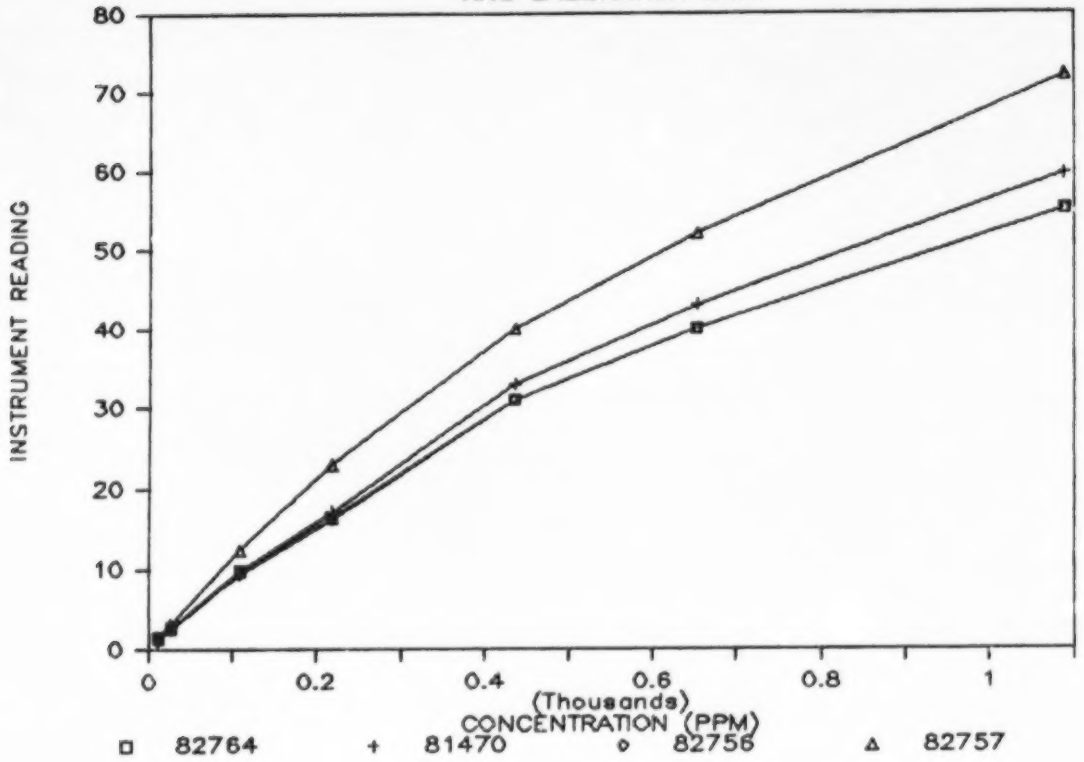
n-BUTYRALDEHYDE - SPAN = 9.8 HNU CALIBRATION DATA

SYNONYMS : n-BUTANAL
SAMPLE : KODAK, NO GRADE SPECIFIED
DATE : 31 JANUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	95	96	96	94	
10.0	11.0	11.3	10.8	11.1	
101	95	98	96	92	
SAMPLES					
5.5	2.1	2.3	2.1	2.1	2.1 (t=9)
10.9	4.1	4.3	4.0	4.2	4.2 (t=9)
22	7.7	8.1	7.5	7.8	7.6 (t=11)
55	17.4	18.5	17.2	17.8	17.2 (t=11)
109	30	31	29	30	29 (t=9)
163	41	43	41	42	41 (t=10)
218	50	53	51	50	50 (t=10)

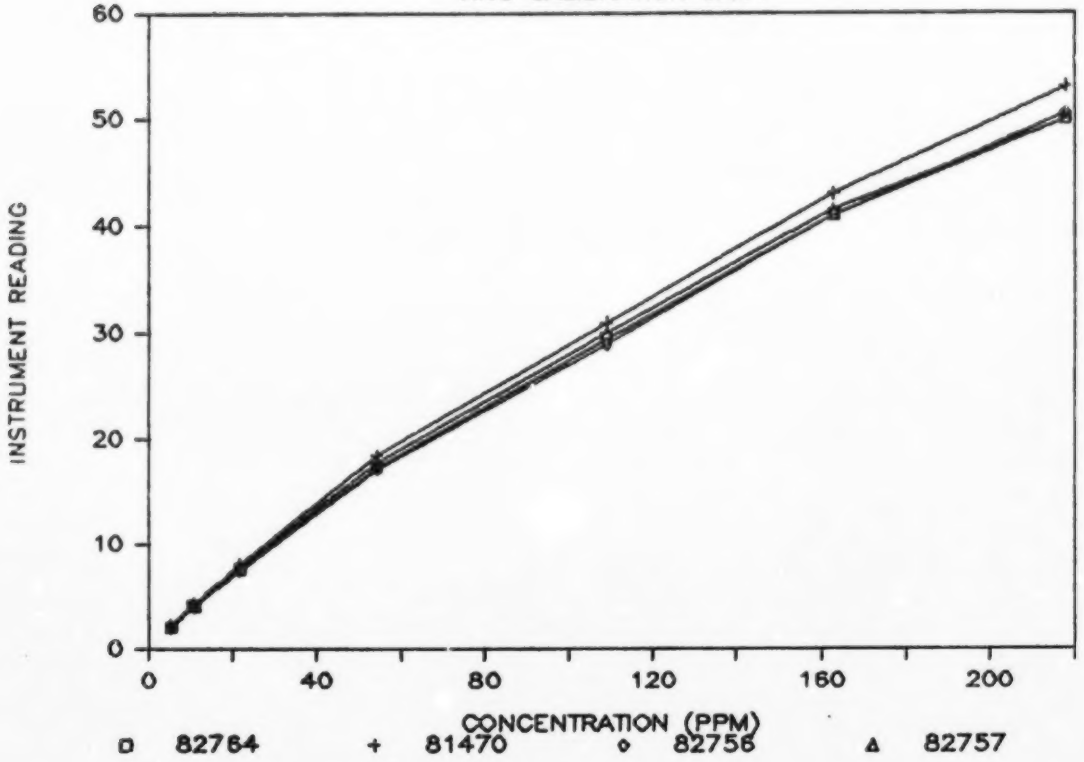
1-BUTANOL - SPAN 9.8

HNU CALIBRATION DATA



n-BUTYRALDEHYDE - SPAN 9.8

HNU CALIBRATION DATA



CARBON DISULFIDE - SPAN = 9.8 HNU CALIBRATION DATA

SAMPLE : FISHER, SPECTRANALYSED REAGENT GRADE
DATE : 12 JANUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS

ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	97	96	95	94	
10.0	11.4	11.4	10.7	11.3	
10.0	11.4	11.5	10.4	10.5	
101	95	97	**87	**81	
101	95	92	87	82	
508	350	310	335	290	

SAMPLES READING FOR ULTRA ZERO AIR IN CLEAN TEDLAR BAG WAS 0.2 ON 82764.
0.2 SUBTRACTED FROM ALL UNIT SAMPLE READINGS BELOW 20.

5.45	2.0	2.0	1.9	2.1	1.9 (t=4)
10.9	4.2	4.0	4.2	4.6	4.1 (t=4)
27	11.0	11.0	11.0	12.1	11.0 (t=7)
49	22	22	22	23	22 (t=4)
82	32	32	32	34	32 (t=4)
109	43	44	43	45	42 (t=5)
163	60	61	61	63	60 (t=6)
218	80	82	80	81	79 (t=6)
545	160	158	163	161	157 (t=6)

NOTES : ** POSSIBLE CONDENSATION OR DEPOSIT ON LIGHT SOURCE WINDOW.

FOR CONCENTRATION 10.9 ONWARDS, MAXIMUM INITIAL READING DROPS RAPIDLY TO STABLE READING. EQUILIBRIUM READINGS REPORTED.

CUMENE - SPAN = 9.8 HNU CALIBRATION DATA

SYNONYMS : ISOPROPYL BENZENE
SAMPLE : POLYSCIENCE CORP., "QUANTITATIVE" GRADE
DATE : 4 JANUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

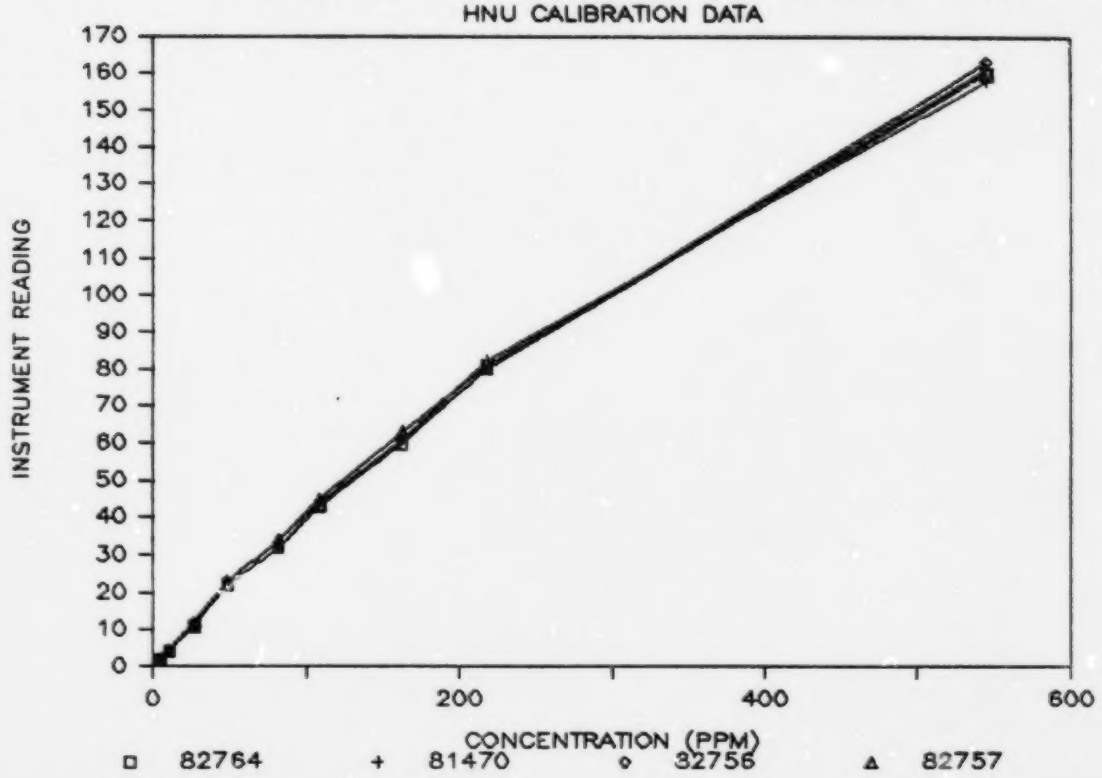
BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81478	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	96	95	96	*96	
10.0	11.3	11.1	10.7	11.6	
101	96	96	95	94	
508	360	320	370	350	
SAMPLES					
5.5	6.7	6.9	6.5	7.0	6.3 (t=10)
10.9	12.3	13.0	12.2	13.0	11.9 (t=9)
27	32	34	32	33	32 (t=8)
55	58	61	58	59	57 (t=8)
82	84	87	85	84	82 (t=8)
136	123	125	125	120	121 (t=9)
272	220	215	220	210	215 (t=9)
436	290	275	300	285	280 (t=9)
1089	420	360	440	410	---

NOTES : * SOME DIFFICULTY IN OBTAINING DESIRED RESPONSE FOR 82757 PRIOR TO START OF CALIBRATION SEQUENCE.

GC ANALYSIS OF THIS SAMPLE REVEALED TWO COMPONENTS IN ROUGHLY EQUAL PROPORTIONS.

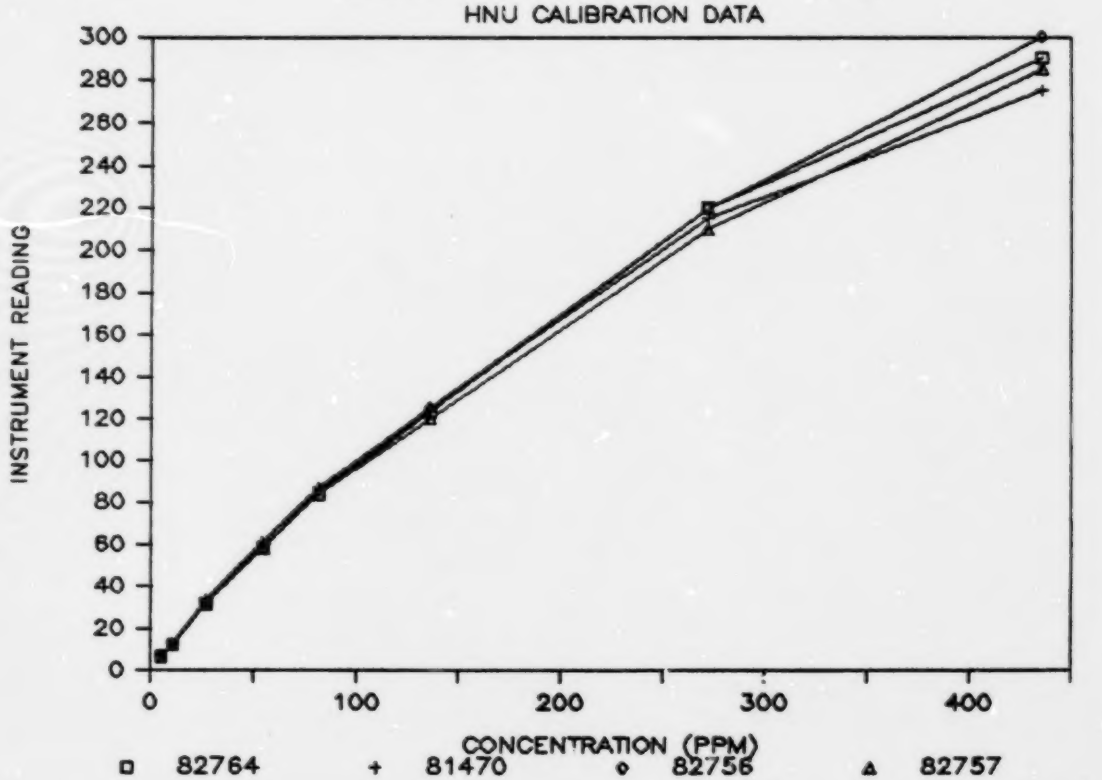
CARBON DISULFIDE — SPAN 9.8

HNU CALIBRATION DATA



CUMENE — SPAN 9.8

HNU CALIBRATION DATA



CYCLOHEXANE - SPAN = 9.8 HNU CALIBRATION DATA

SAMPLE : J.T. BAKER, REAGENT GRADE
DATE : 13 DECEMBER, 1983
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	11.2	12.0	10.2	11.4	
101	96	106	92	99	
508	370	380	360	350	
SAMPLES					
5.5	2.4	2.5	2.1	2.7	2.3 (t=6)
27	10.3	10.7	9.8	11.6	10.1 (t=6)
55	18.8	21	18.5	22	18.7 (t=7)
109	38	42	37	41	38 (t=7)
218	65	72	65	71	---
327	91	101	90	104	89 (t=7)
545	123	138	123	150	122 (t=7)
980	163	182	165	194	162 (t=7)

1,2-DIBROMOETHANE - SPAN = 9.8 HNU CALIBRATION DATA

SYNONYMS : ETHYLENE DIBROMIDE, EDB
SAMPLE : J.T. BAKER, "BAKER" GRADE
DATE : 3 JANUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

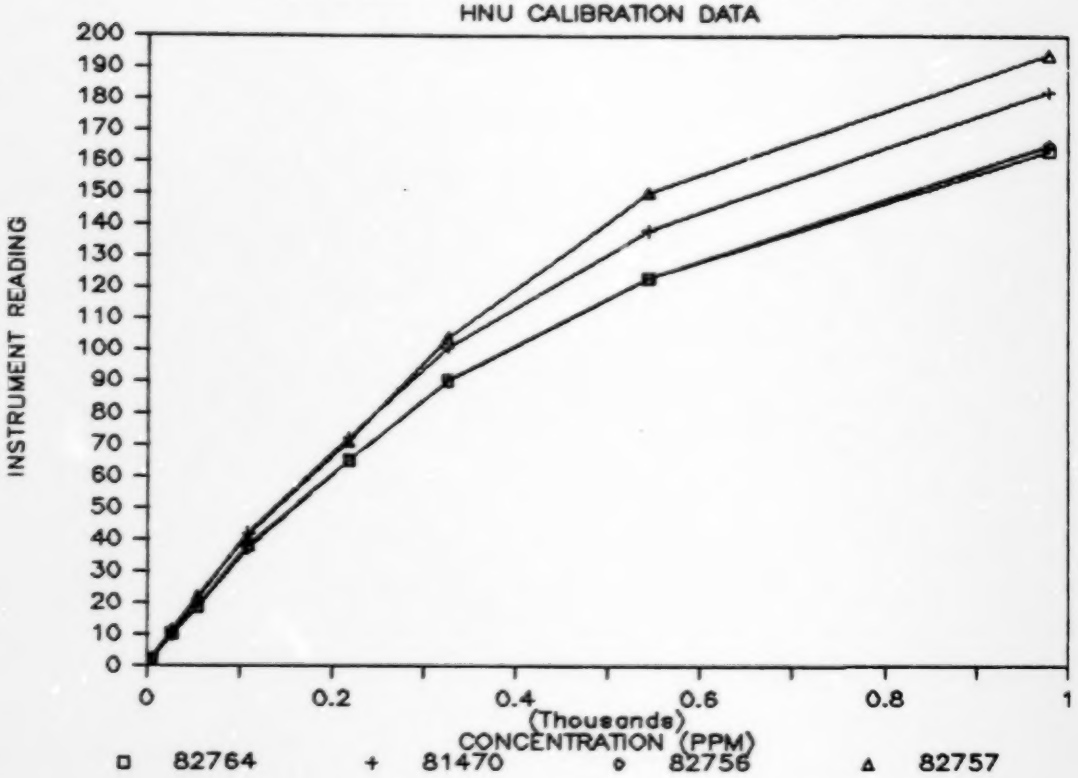
BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x SERIAL NO. 82764 (min.)
0.0	0.0	0.0	0.0	0.0	
101	96	98	96	99	
10.0	11.4	11.5	10.8	11.7	
10.0	11.2	11.6	10.7	13.1	
101	95	100	96	106	
508	350	340	370	390	
SAMPLES					
5.45	1.8	1.9	1.8	2.1	1.7 (t=9)
16.4	4.2	4.7	4.3	5.4	4.1 (t=10)
55	13.5	16.4	14.5	19.3	13 (t=10)
109	24	29	26	35	24 (t=8)
163	36	43	38	50	34 (t=10)
327	59	72	65	82	59 (t=6)
653	91	113	100	137	89 (t=7)
980	107	132	117	153	106 (t=9)

NOTES : INSTRUMENT 82757 SHOWED SIGNIFICANT INCREASE IN RESPONSE AS INDICATED BY 10.0 AND 101 ppm BENZENE DATA.

LIGHT SOURCE WINDOWS ALL CLEANED PRIOR TO START, AND INTERNAL ADJUSTMENT OF 81470 (DOWN) AND 82756 (UP) TO READ 96 FOR BENZENE 101 ppm.

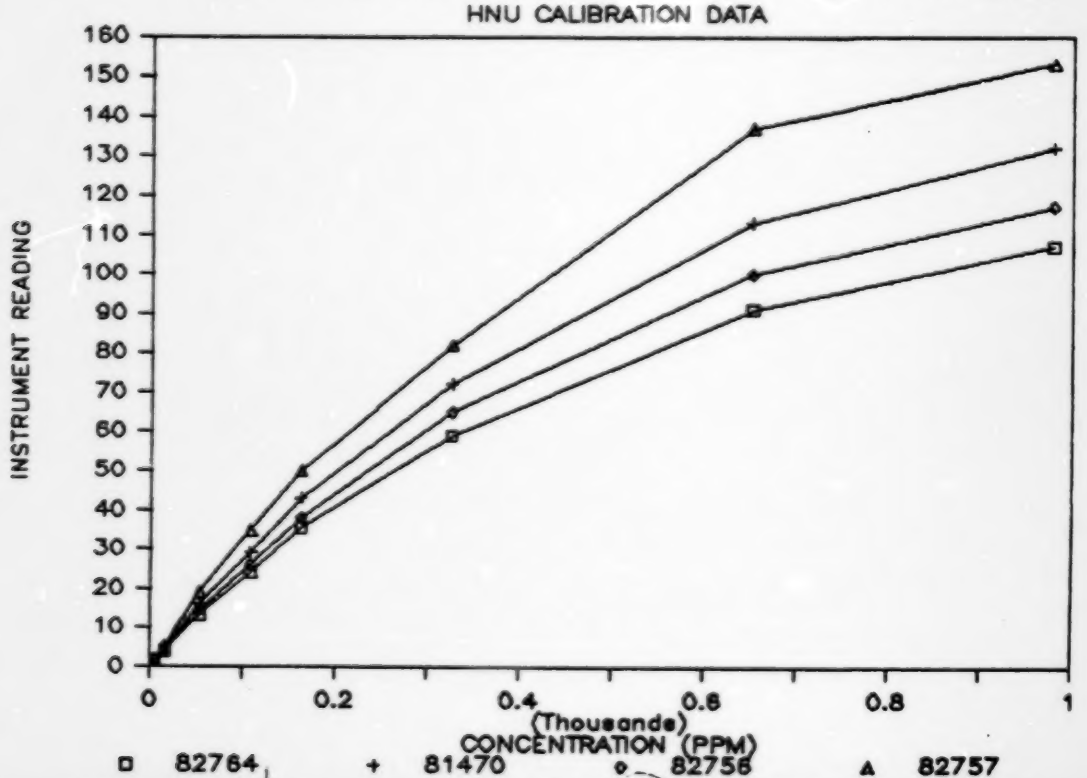
CYCLOHEXANE – SPAN 9.8

HNU CALIBRATION DATA



1,2–DIBROMOETHANE – SPAN 9.8

HNU CALIBRATION DATA



1,2-DICHLOROBENZENE - SPAN=9.8 HNU CALIBRATION DATA

SYNONYMS : o-DICHLOROBENZENE
SAMPLE : J.T. BAKER, REAGENT GRADE
DATE : 5 DECEMBER, 1983
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS

ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	9.9	10.7	10.4	12.3	
101	86	94	94	102	
101	86	94	94	96	
508	330	320	360	360	

SAMPLES

5.45	6.9	7.6	7.1	8.5	6.9 (t=7)
10.9	12.3	13.8	13.2	15.4	12.1 (t=18)
22	26	28	28	32	26 (t=17)
44	52	57	57	61	51 (t=14)
87	90	102	101	113	88 (t=17)
131	129	146	146	160	124 (t=17)
218	177	200	200	210	175 (t=17)
436	300	320	330	350	300 (t=5)

ETHANOL - SPAN = 9.8 HNU CALIBRATION DATA

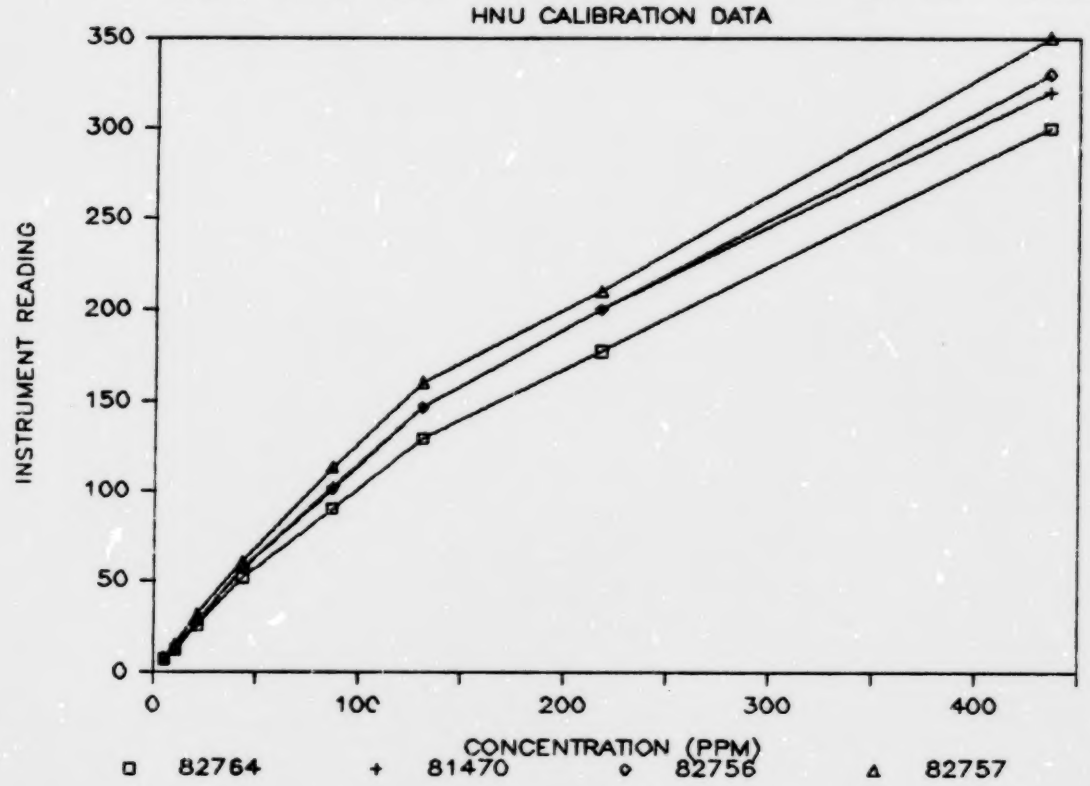
SYNONYMS : ETHYL ALCOHOL
SAMPLE : CONSOLIDATED ALCOHOLS, ABSOLUTE
DATE : 19 JANUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	96	95	95	95	
10.0	11.1	11.1	10.6	11.5	
10.0	11.2	11.1	10.6	11.2	
101	96	96	95	92	
SPAN GAS	60	60	58	57	
SAMPLES					
AIR BLANK	0.2	0.1	0.2	0.15	
22	0.8	0.8	0.8	1.0	0.85 (t=8)
55	2.0	1.9	1.9	2.3	2.0 (t=7)
163	5.7	5.9	5.5	6.6	5.7 (t=8)
327	10.2	11.0	9.9	11.8	10.1 (t=9)
545	15.5	17.1	15.3	18.3	15.4 (t=8)
1089	28	31	27	32	28 (t=8)
2178	40	45	38	47	40 (t=6)

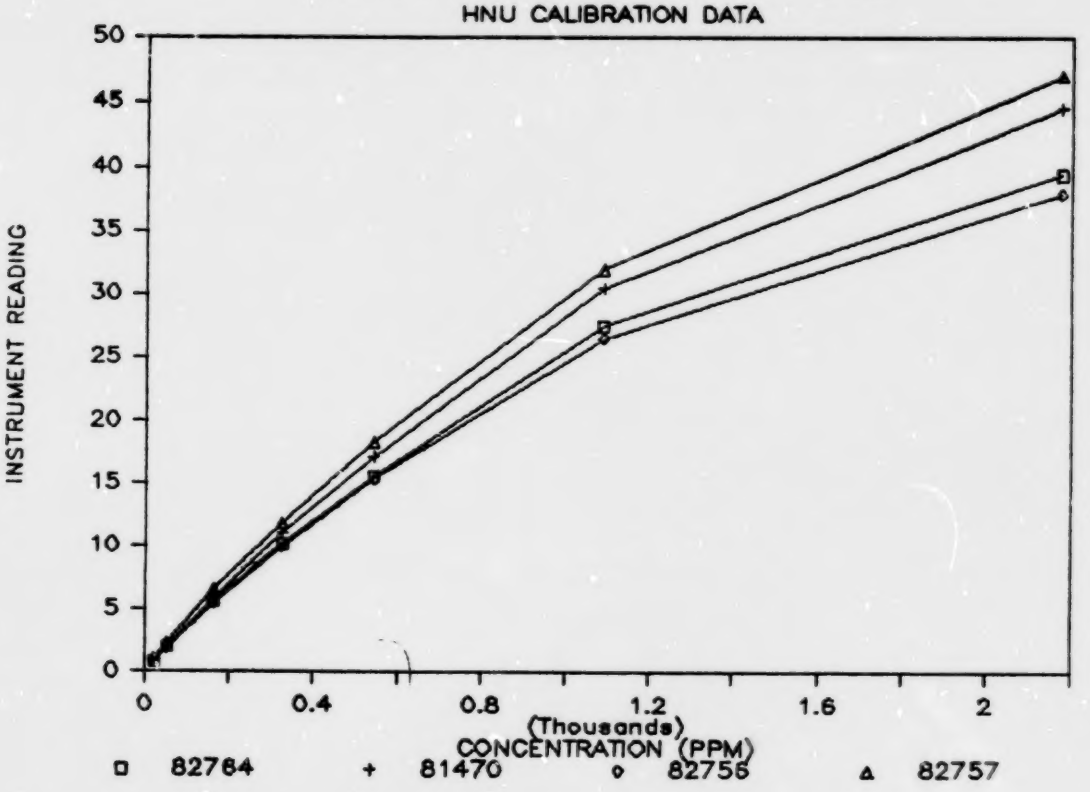
NOTES : INITIAL BENZENE STANDARD READING ON 82764 AT 101 ppm WAS 82. INTERNAL ADJUSTMENT WAS MADE TO BRING IT TO 96.

AIR BLANK - READINGS FOR ZERO AIR IN CLEAN TEDLAR BAGS IS LISTED. TAKEN AS 0.2 FOR ALL INSTRUMENTS AND SUBTRACTED FROM ALL SAMPLE READINGS LESS THAN 20.

1,2-DICHLOROBENZENE - SPAN 9.8



ETHANOL - SPAN 9.8



ETHYL BENZENE - SPAN 9.8 HNU CALIBRATION DATA

SAMPLE : POLYSCIENCE CORP., "QUANTITATIVE" GRADE
DATE : 5 JANUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	97	94	95	96	
10.0	11.2	10.8	10.6	11.6	
101	96	93	95	94	
508	360	310	370	350	
SAMPLES					
5.45	6.7	6.5	6.3	6.7	6.4 (t=11)
10.9	13.3	13.2	12.4	13.1	12.4 (t=8)
33	40	40	39	40	39 (t=7)
65	73	72	70	70	71 (t=8)
95	101	102	98	97	97 (t=8)
163	159	154	159	153	155 (t=4)
272	240	220	240	230	230 (t=6)
545	360	320	370	350	360 (t=8)
1089	460	390	480	460	

2-ETHYL HEXANOL - SPAN = 9.8 HNU CALIBRATION DATA

SYNONYM : 2-ETHYL-1-HEXANOL
SAMPLE : KODAK, 99% MINIMUM.
DATE : 16 JANUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	96	96	96	95	
10.0	11.2	11.1	10.8	11.8	
10.0	10.4	11.1	10.8	11.2	
101	83	96	96	94	
SAMPLES					
5.45	2.9	2.8	2.9	3.3	2.9 (t=41)
10.9	5.8	6.1	5.9	6.5	5.7 (t=37)
33	14.1	16.1	15.2	16.5	13.3 (t=34)
65	25	31	29	31	25 (t=31)
109	36	46	42	44	45 (t=29)

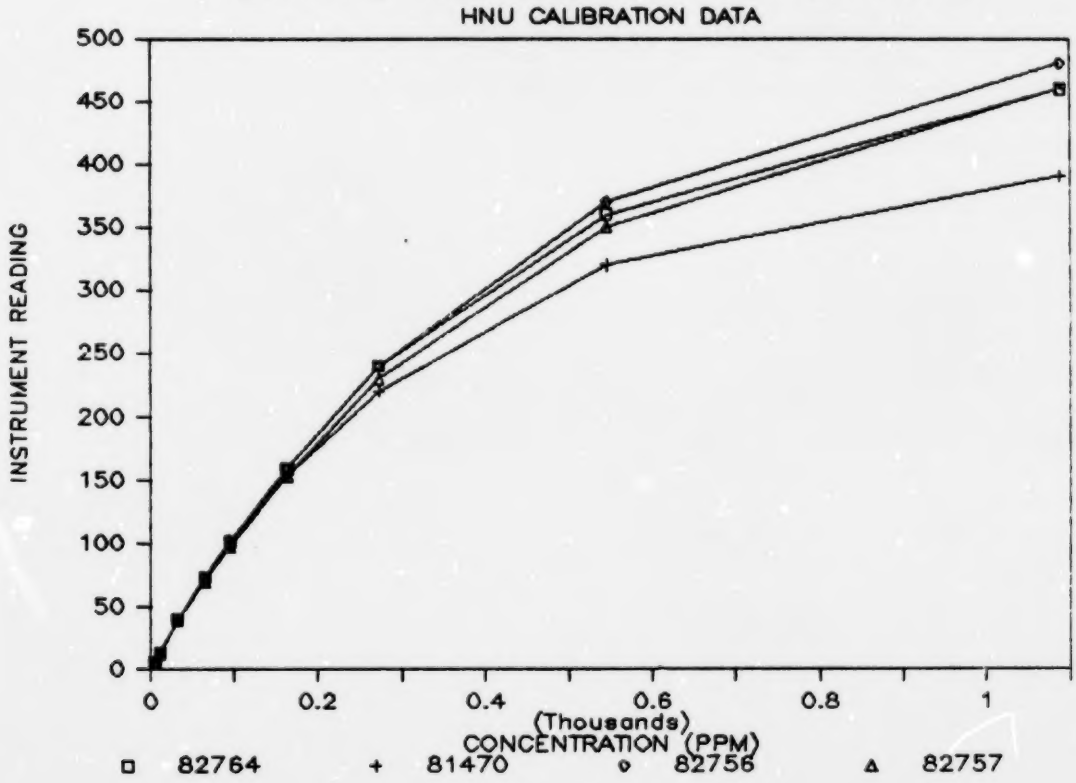
NOTES : LIGHT SOURCE WINDOWS ALL CLEANED PRIOR TO START AND INTERNAL ADJUSTMENTS OF 81470, 82756, AND 82757 TO READ APPROXIMATELY 96 ON 101 ppm BENZENE.

READING FOR ZERO AIR IN CLEAN TEDLAR BAG WAS TAKEN ON 82764 AND FOUND TO BE 0.2. BLANK TAKEN AS 0.2 FOR ALL INSTRUMENTS.

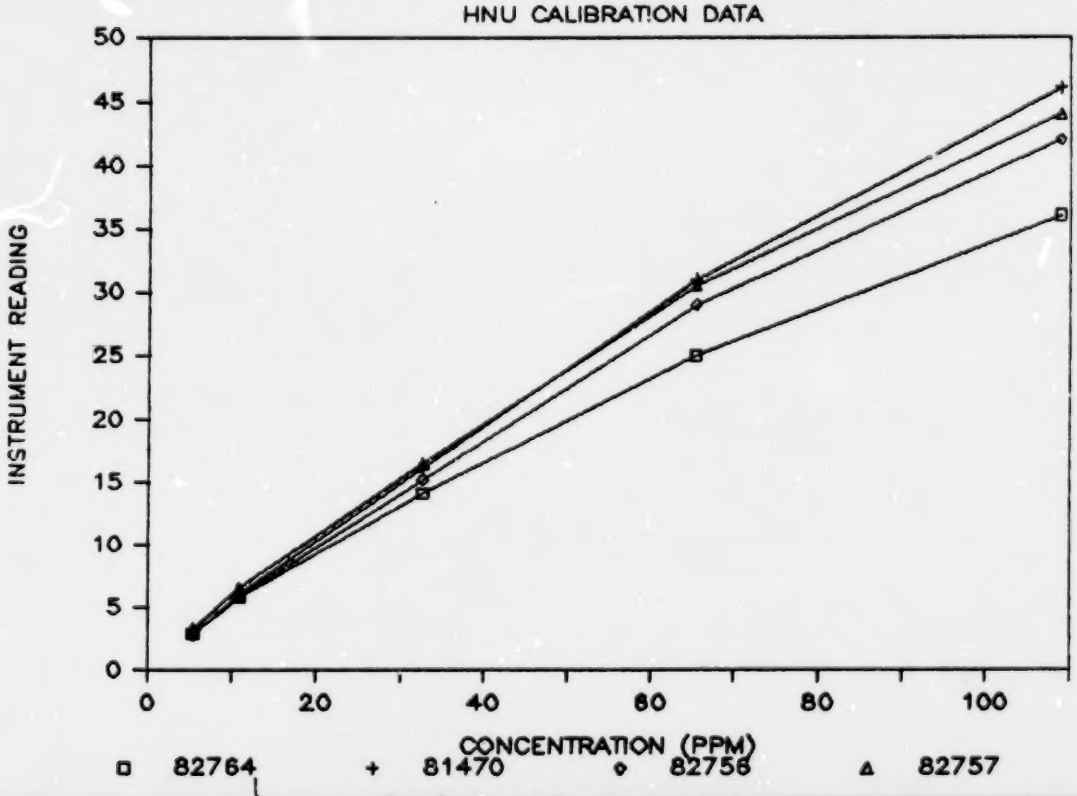
A SIGNIFICANT DECREASE IN RESPONSE WAS RECORDED FOR 82764 WITH TIME.

VERY SLOW RESPONSE AT ALL CONCENTRATIONS. 81470 SLOWEST, 6 MINUTES FOR MAXIMUM READING AT 5.5 ppm, 4 MINUTES AT 109 ppm.

ETHYL BENZENE -- SPAN 9.8



2-ETHYL-1-HEXANOL -- SPAN 9.8



n-HEXANE - SPAN=9.8, 2.0 HNU CALIBRATION DATA

SAMPLE : J.T. BAKER, PHOTREX REAGENT GRADE
DATE : 10 JANUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	95	98	340	96	
10.0	11.4	11.4	37	11.5	
10.0	11.2	11.1	37	11.5	
101	96	94	340	95	
SAMPLES					
5.5	0.6	0.6	2.1	0.7	0.6 (t=7)
10.9	1.4	1.3	4.3	1.5	1.2 (t=8)
33	3.3	3.4	11.9	4.4	3.3 (t=6)
65	6.9	7.0	25	8.7	6.6 (t=6)
98	9.2	9.4	34	11.8	8.9 (t=7)
163	14.9	15.7	55	19.0	14.5 (t=7)
327	26	28	94	34	26 (t=6)
545	38	40	132	47	37 (t=6)
762	45	47	162	59	45 (t=7)

NOTES : SPAN = 2.0 FOR INSTRUMENT 82756. ALL OTHERS SPAN = 9.8.

READINGS FOR TEDLAR BAG AIR BLANK WERE 0.2 ON INSTRUMENTS SET AT SPAN 9.8. 82756 AIR BLANK WAS 0.6. BLANK VALUES SUBTRACTED FROM SAMPLE DATA VALUES LESS THAN 20.

ISOPROPANOL - SPAN=9.8, 2.0 HNU CALIBRATION DATA

SYNONYMS : 2-PROPANOL, ISOPROPYL ALCOHOL
SAMPLE : FISHER, A.C.S. REAGENT GRADE
DATE : 11 JANUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	96	94	340	95	
10.0	11.2	10.9	37	95	
10.0	10.6	10.6	37	11.2	
101	88	96	340	93	
SAMPLES					
10.9	1.1	0.9	3.4	1.9	1.1 (t=11)
27	2.7	2.2	8.1	4.1	2.6 (t=10)
55	4.6	4.0	15.3	6.9	4.5 (t=9)
109	8.3	7.7	29	11.4	7.8 (t=8)
218	14.8	15.1	57	21	14.5 (t=8)
436	27	28	100	35	25 (t=7)
762	37	40	143	49	36 (t=7)
1089	44	49	172	59	43 (t=7)

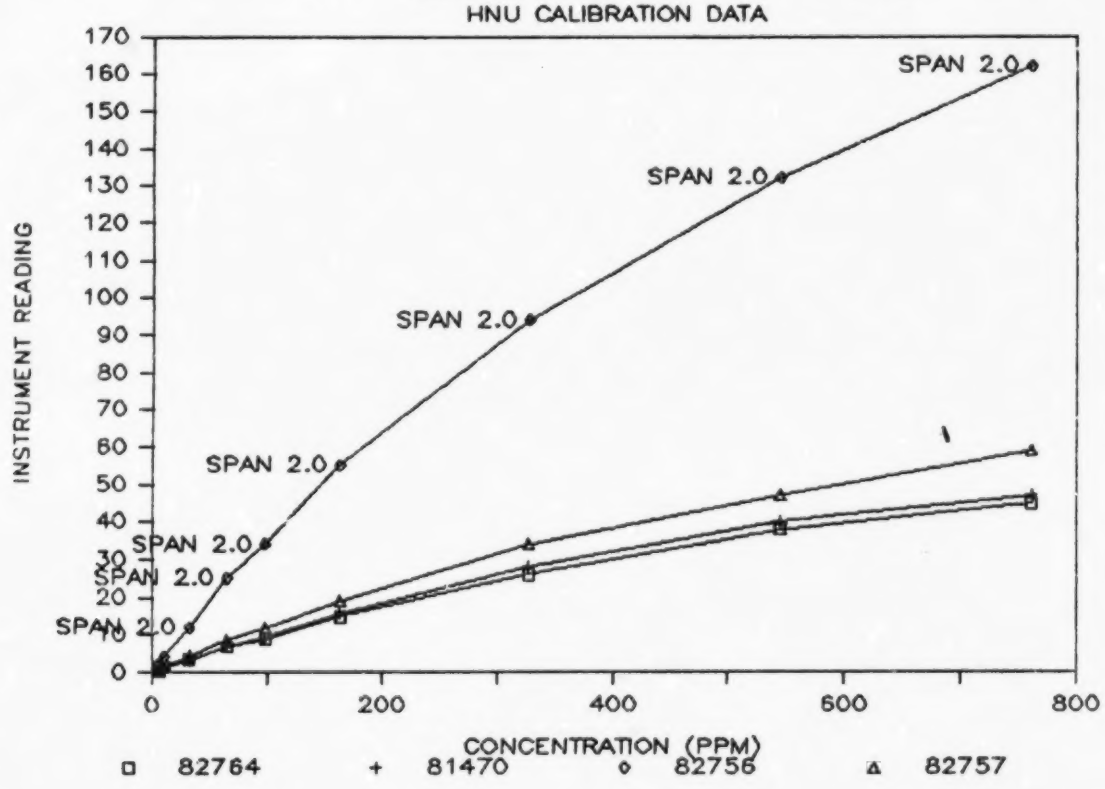
NOTES : SPAN = 2.0 FOR INSTRUMENT 82756. ALL OTHERS SPAN = 9.8.

READINGS FOR TEDLAR BAG AIR BLANK WERE 0.2 ON INSTRUMENTS 81470 AND 82757. TEDLAR AIR BLANK ON INSTRUMENT 82764 WAS 0.3. 82756 WAS 0.6. BLANK VALUES SUBTRACTED FROM SAMPLE DATA VALUES LESS THAN 20.

A SIGNIFICANT DROP IN THE 101 ppm BENZENE READING FOR 82764 DURING THE TEST WAS NOTED.

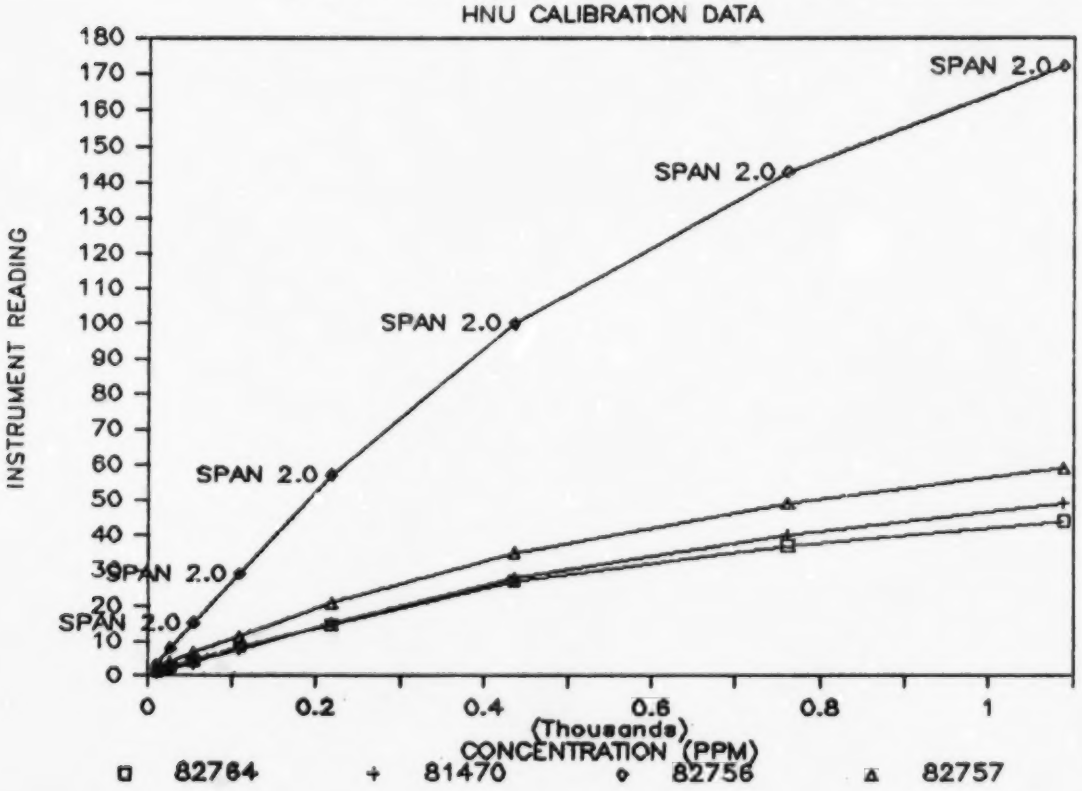
n—HEXANE — SPAN 9.8

HNU CALIBRATION DATA



ISOPROPANOL — SPAN 9.8

HNU CALIBRATION DATA



METHYLENE CHLORIDE - SPAN=9.8 HNU CALIBRATION DATA

SYNONYM : DICHLOROMETHANE
SAMPLE : SARGENT-WELCH, REAGENT GRADE
DATE : 20 JANUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	96	96	94	93	
10.0	11.1	10.9	10.6	11.1	
SAMPLES					
55	0.8	0.7	0.7	0.8	
109	1.4	1.2	1.3	1.4	
263	3.0	2.8	2.8	3.1	
545	5.3	5.0	4.9	5.5	
817	7.2	6.9	6.7	---	

NOTES : ALL REPORTED READINGS MUST BE DUE TO IMPURITIES IN SAMPLE SINCE THE IONIZATION POTENTIAL FOR DICHLOROMETHANE IS >>10.2 eV.

METHYL ETHYL KETONE - SPAN=9.8 HNU CALIBRATION DATA

SYNONYM : MEK
SAMPLE : J.T. BAKER, REAGENT GRADE
DATE : 30 NOVEMBER, 1983
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	17.2	9.8	9.8	9.8	
101	148	89	101	97	
508	560	320	380	360	
SAMPLES					
5	7.9	5.1	5.2	5.4	
25	26	17.3	17.4	17.1	26 (t=8)
50	48	33	33	32	48 (t=8)
100	88	60	61	58	86 (t=6)
250	190	117	131	121	190 (t=7)
500	350	210	240	220	340 (t=8)
1000	480	280	335	320	480 (t=7)

NOTE : INSTRUMENT 82764 SET TO A SPAN SETTING OF 5.7.

METHYL ISOBUTYL KETONE - SPAN=9.8 HNU CALIBRATION DATA

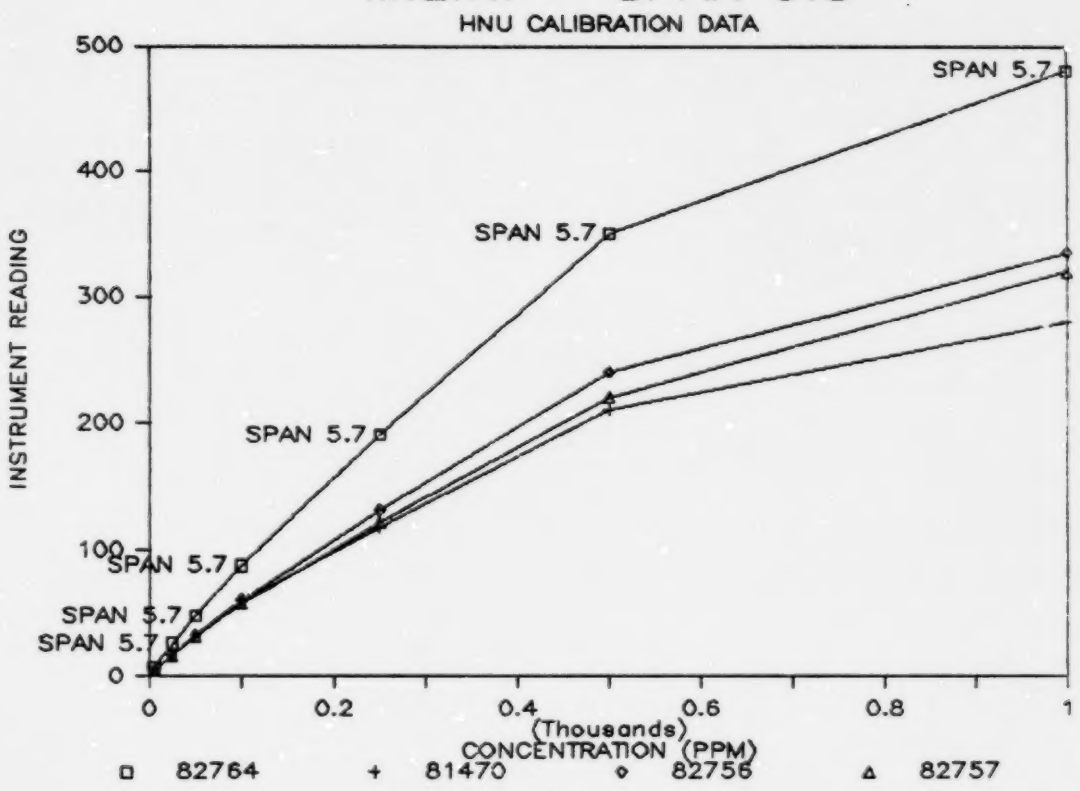
SYNONYM : MIBK
SAMPLE : J.T. BAKER, REAGENT GRADE
DATE : 2 DECEMBER, 1983
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	---	9.6	9.8	9.8	
101	142	93	95	96	
508	540	340	360	400	
SAMPLES					
27	26	15.8	15.2	17.8	26 (t=13)
55	49	34	32	37	48 (t=10)
109	91	59	61	63	90 (t=10)
272	194	132	128	134	189 (t=12)
545	300	200	200	210	300 (t=9)

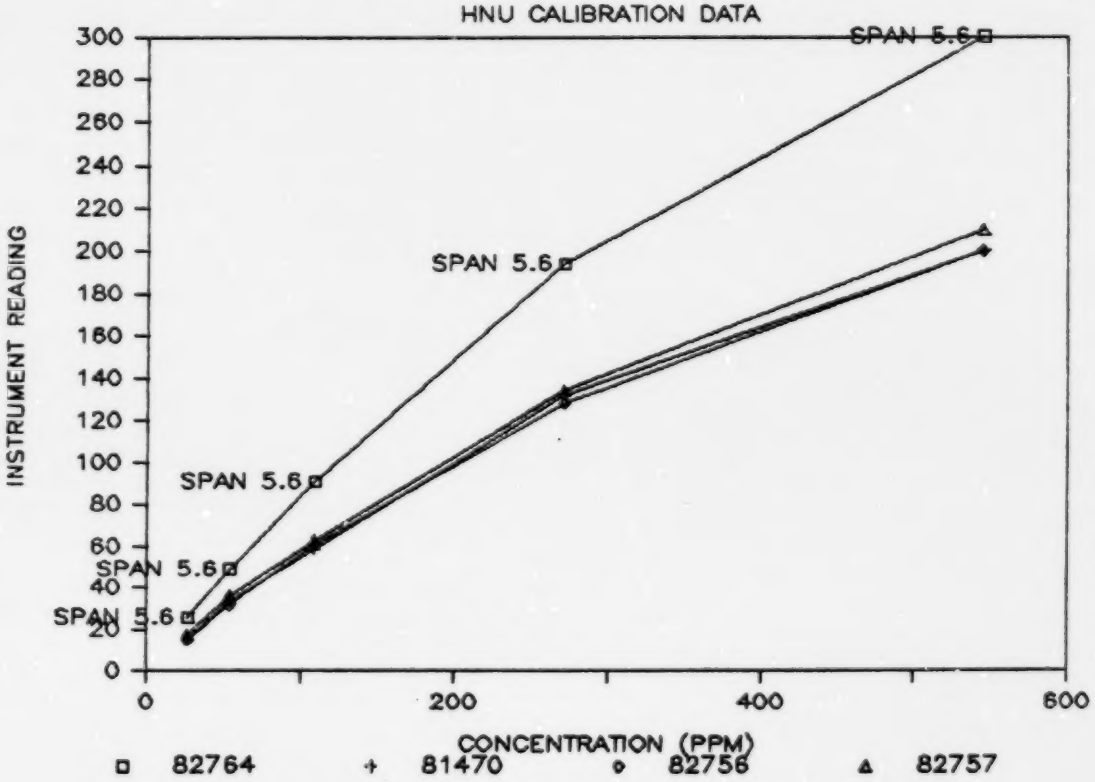
NOTE : INSTRUMENT 82764 SET TO A SPAN SETTING OF 5.6.

VERY SLOW RESPONSE, ESPECIALLY FOR 81470.

M.E.K. — SPAN 9.8



M.I.B.K. — SPAN 9.8



METHYL METHACRYLATE - SPAN=9.8 HNU CALIBRATION DATA

SAMPLE : J.T. BAKER, "BAKER" GRADE
DATE : 12 DECEMBER, 1983
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	11.2	11.2	10.4	12.8	
10.0	11.1	*12.3	10.4	13.2	
101	96	108	92	107	
509	370	380	360	390	
101	96	107	92	107	
SAMPLES					
5.5	2.6	3.0	2.4	3.5	2.8 (t=12)
16.4	6.8	7.5	6.3	8.6	6.6 (t=11)
27	11.1	12.2	10.4	13.9	11.0 (t=13)
55	22	24	21	27	22 (t=9)
109	41	45	39	49	40 (t=10)
163	60	66	58	70	58 (t=9)
272	86	96	84	100	85 (t=10)
545	145	161	143	169	142 (t=10)
1089	215	230	210	250	215 (t=9)
1634	250	255	240	250	250 (t=5)

NOTE : * 10% INCREASE IN RESPONSE OVER A 50 MINUTE INTERVAL. PROBABLY A SUDDEN EVENT RATHER THAN GRADUAL.

MORPHOLINE - SPAN=9.8 HNU CALIBRATION DATA

SAMPLE : KODAK, A.C.S. REAGENT GRADE
DATE : 10 JANUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	95	96	95	97	
10.0	11.0	11.0	10.5	11.6	
101	89	84	92	93	
508	340	300	360	360	
101	91	86	93	95	
SAMPLES					
5.5	3.5	3.5	3.6	---	3.3 (t=34)
16.4	11.3	11.4	11.5	10.9	---
27	15.7	16.3	16.6	16.5	15.9 (t=17)
55	31	34	36	35	32 (t=12)
109	56	61	61	62	56 (t=15)
163	84	91	92	91	82 (t=14)
545	230	220	250	250	230 (t=13)
1089	340	310	390	360	340 (t=12)

NOTE : VERY SLOW RESPONSE FOR CONCENTRATION 5.5 ppm. 81470 REQUIRED 8-9 MINUTES TO REACH MAXIMUM. 3-4 MINUTES FOR OTHER INSTRUMENTS.

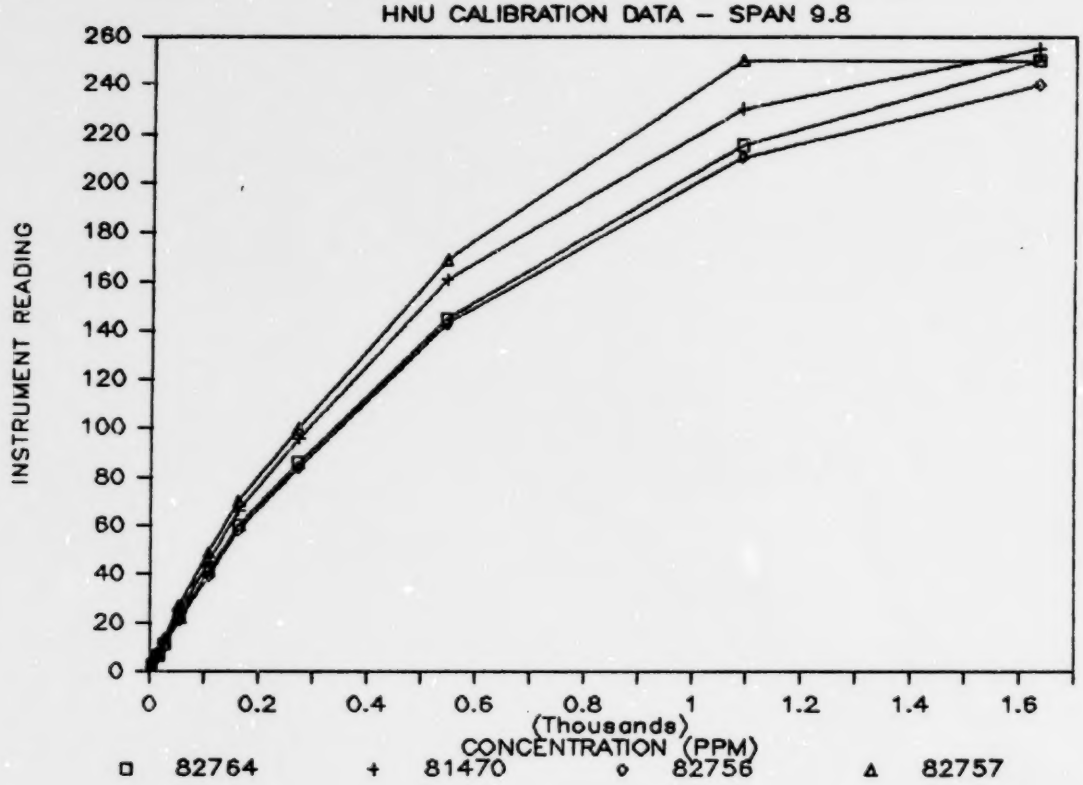
RESULTS REPORTED ARE MAXIMUM READINGS. AFTER REACHING MAXIMUM, READINGS DROP OFF RAPIDLY. AT 55 ppm, 82756 DROPPED FROM 36 TO 27 OVER 4 MINUTES AND WAS STILL FALLING. THIS PHENOMENON WAS NOT SEEN WITH ANY OTHER COMPOUND.

SIGNIFICANT DROP IN RESPONSE FOR 82764 AND 81470, AS INDICATED BY 101 ppm BENZENE RESPONSE, MAY BE DUE TO CONDENSATION OR DEPOSIT ON LIGHT SOURCE WINDOW.

FAST RESPONSE WAS NOTED AT HIGHER CONCENTRATIONS. MAXIMUM READING AT 545 ppm OCCURRED APPROXIMATELY 10 SECONDS.

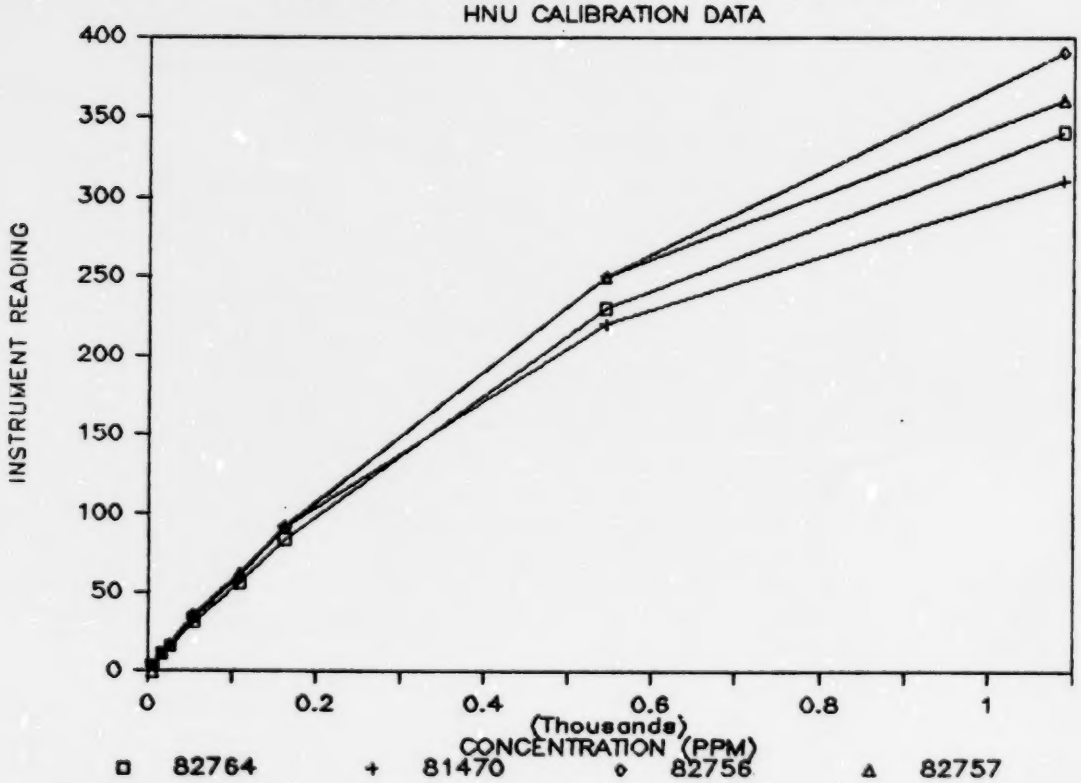
METHYL METHACRYLATE

HNU CALIBRATION DATA – SPAN 9.8



MORPHOLINE – SPAN 9.8

HNU CALIBRATION DATA



PROPYLENE OXIDE - SPAN = 9.8 HNU CALIBRATION DATA

SAMPLE : J.T. BAKER, "BAKER" GRADE
DATE : 1 FEBRUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	95	99	96	93	
SAMPLES					
0	0	0	0	0	
545	30	35	31	35	
1089	47	54	48	55	46 (t=4)

NOTE : TRUE RESPONSE FOR PROPYLENE OXIDE RATHER THAN IMPURITIES.

STYRENE - SPAN=9.8 HNU CALIBRATION DATA

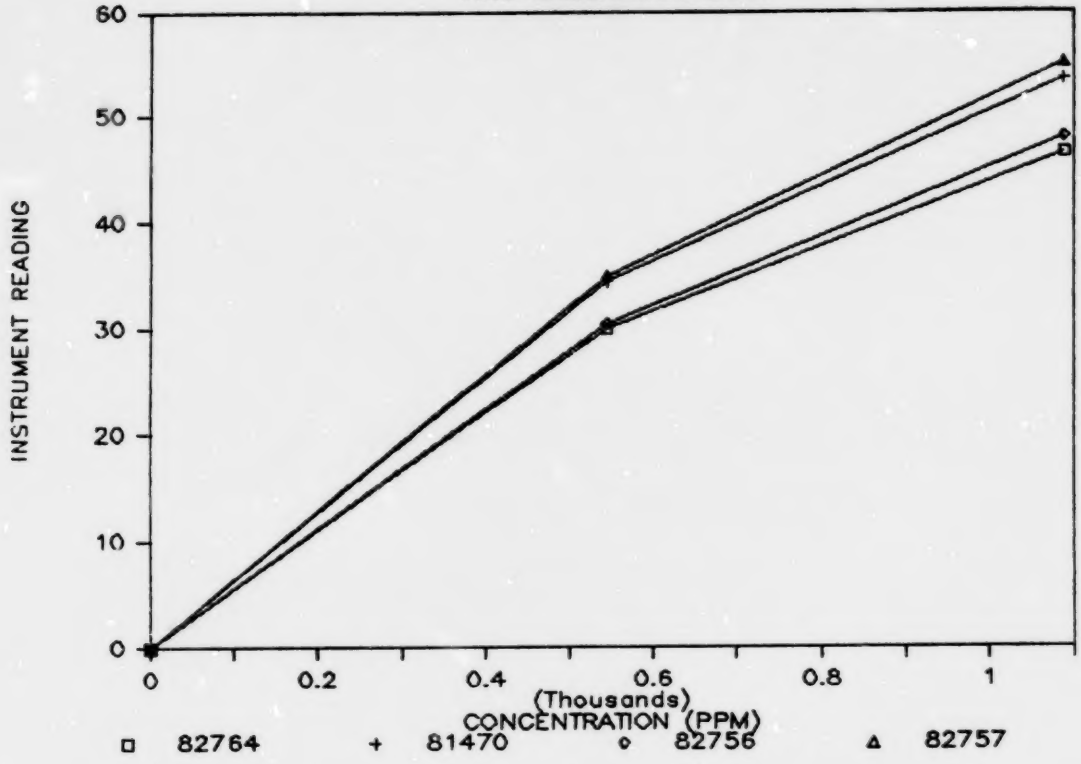
SAMPLE : J.T. BAKER, "BAKER" GRADE
DATE : 16 DECEMBER, 1983
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	11.3	11.8	10.1	11.4	
101	109	105	91	105	
508	400	370	355	390	
SAMPLES					
5.5	8.4	10.1	7.6	8.5	8.5 (t=10)
10.9	17.5	19.3	15.1	18.8	17.0 (t=11)
27	43	44	37	43	43 (t=10)
55	81	83	70	80	80 (t=10)
109	150	151	131	144	149 (t=9)
163	220	210	182	196	220 (t=11)
272	310	285	270	285	310 (t=10)
545	490	420	430	450	480 (t=10)

NOTE : THE 101 ppm BENZENE STANDARD RESPONSES WERE ABOUT 10 % HIGHER THAN THE PREVIOUS DAYS' READINGS.

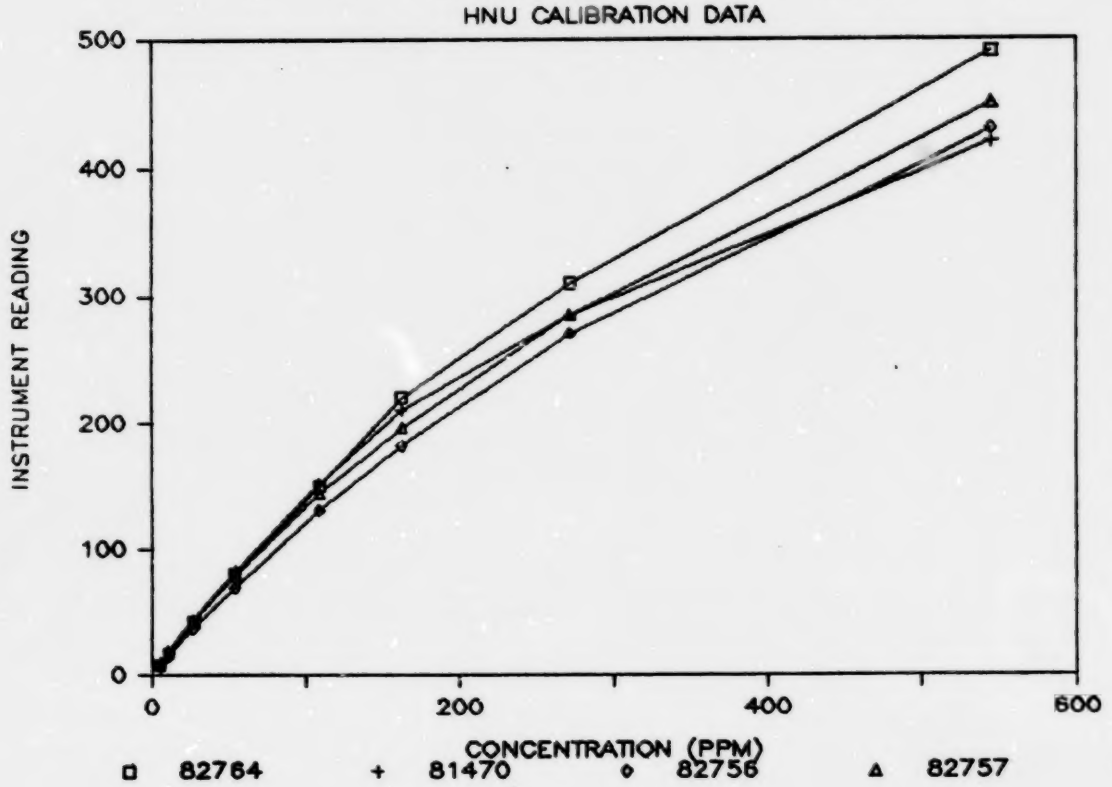
PROPYLENE OXIDE — SPAN 9.8

HNU CALIBRATION DATA



STYRENE — SPAN 9.8

HNU CALIBRATION DATA



TETRACHLOROETHYLENE - SPAN=9.8 HNU CALIBRATION DATA

SAMPLE : J.T. BAKER, REAGENT GRADE
DATE : 10 DECEMBER, 1983
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	10.4	9.7	11.0	11.6	
101	89	87	96	99	
508	340	320	370	390	
SAMPLES					
5.5	5.6	5.4	5.9	6.4	5.6 (t=7)
16.4	14.2	12.9	14.8	16.3	14.2 (t=9)
55	52	50	55	58	51 (t=7)
109	88	87	92	97	84 (t=10)
163	130	130	142	144	127 (t=9)
272	178	184	200	210	175 (t=10)
545	320	315	350	350	310 (t=7)
1089	400	390	445	480	400 (t=9)

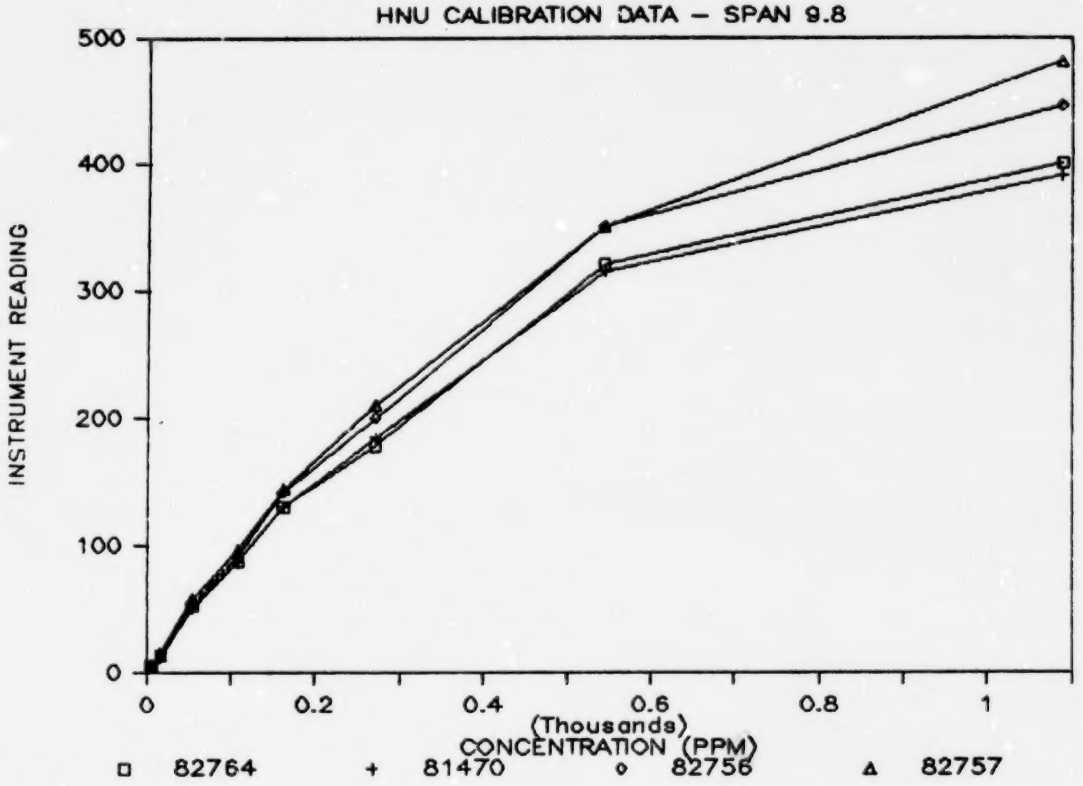
TOLUENE - SPAN=9.8 HNU CALIBRATION DATA

SAMPLE : J.T. BAKER, REAGENT GRADE
DATE : 29 NOVEMBER, 1983
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	10.8	10.1	11.0	11.2	
101	94	93	102	95	
508	360	360	400	350	
SAMPLES					
5.0	6.0	5.8	5.8	6.1	5.8 (t=6)
15.0	15.4	15.0	15.8	16.0	15.2 (t=6)
40	42	42	44	43	42 (t=7)
75	75	75	80	74	74 (t=8)
150	137	146	151	139	130 (t=9)
250	210	225	230	215	210 (t=8)
500	360	360	400	355	355 (t=8)
750	440	430	495	450	440 (t=6)

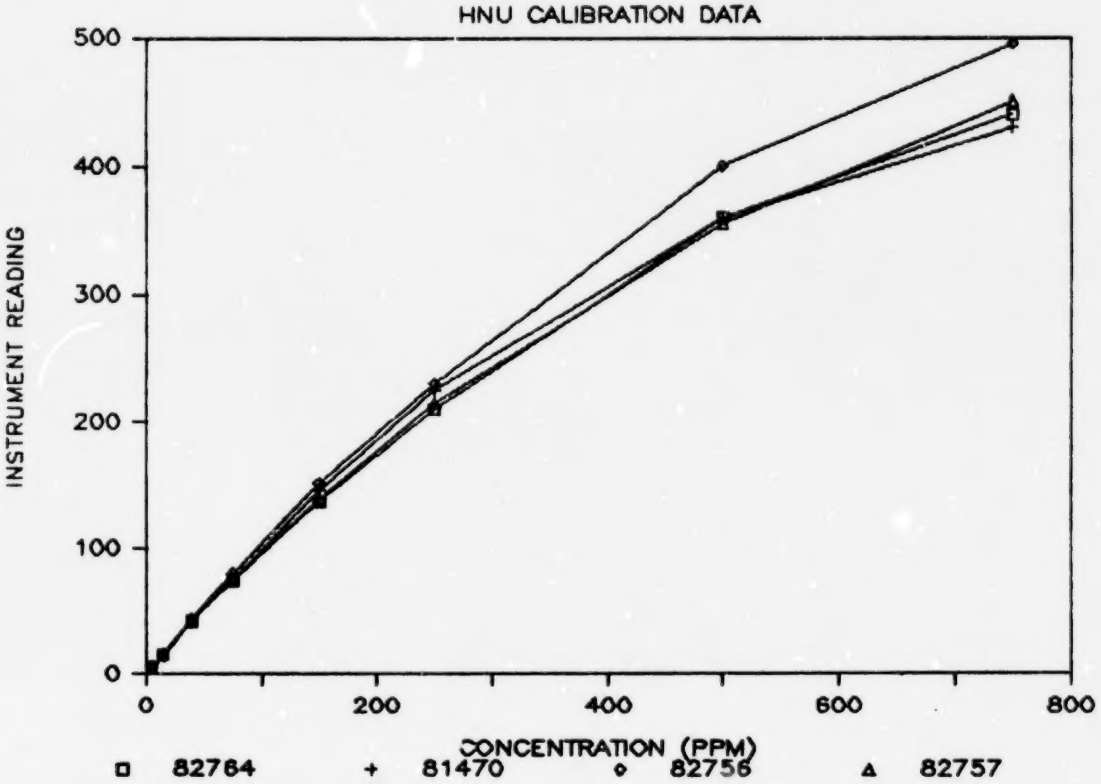
TETRACHLOROETHYLENE

HNU CALIBRATION DATA – SPAN 9.8



TOLUENE – SPAN 9.8

HNU CALIBRATION DATA



TURPENTINE - SPAN=9.8 HNU CALIBRATION DATA

SAMPLE : RECOCHEM
DATE : 26 JANUARY, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	96	96	96	95	
10.0	11.2	11.1	10.7	11.2	
101	97	96	96	92	
508	360	320	370	340	
SAMPLES					
5.5	9.8	10.4	9.4	9.9	9.8 (t=11)
10.9	18.5	19.8	18.2	18.5	18.6 (t=11)
29	48	50	47	47	48 (t=9)
55	82	84	83	79	82 (t=10)
82	115	113	116	110	114 (t=12)
136	186	170	183	169	177 (t=10)
327	315	270	325	300	315 (t=8)
545	400	300	400	350	395 (t=10)

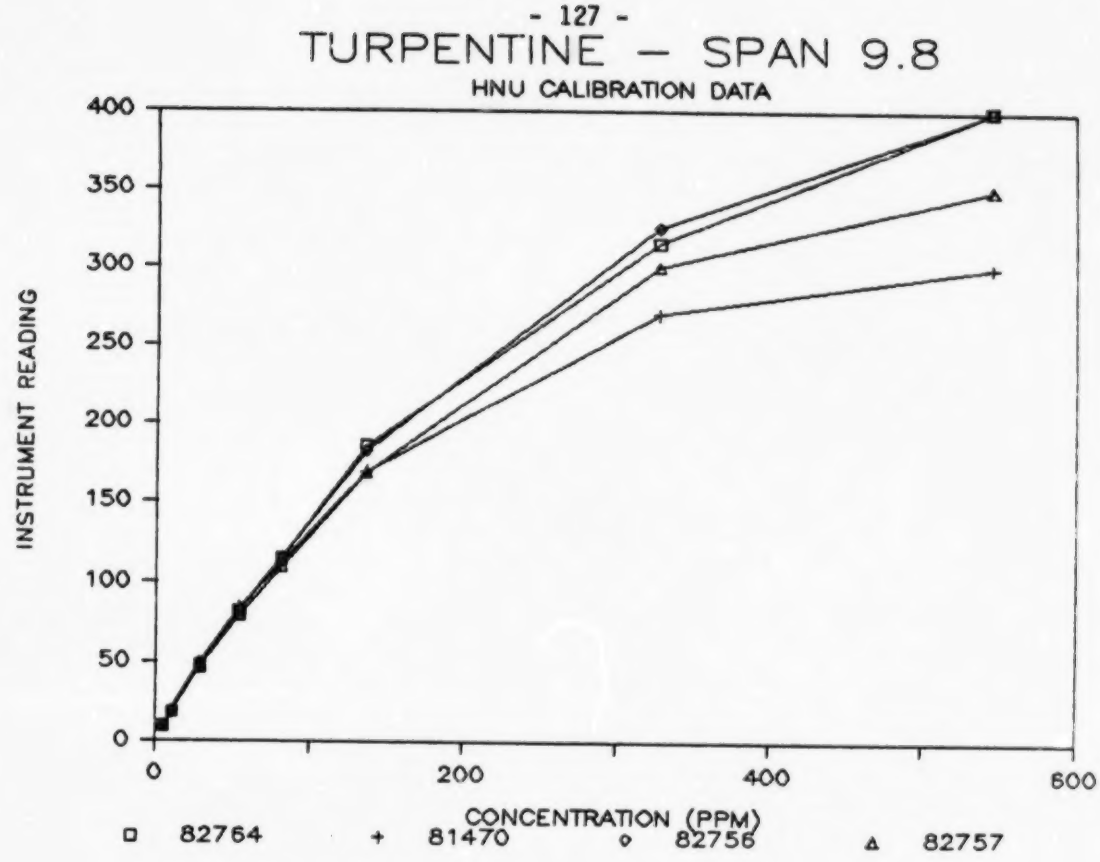
NOTE : MAXIMUM INITIAL READINGS FOR HIGHEST 3 CONCENTRATIONS DROP TO STABLE READINGS ON 82764 AND 82756. READINGS CONTINUE TO DROP SLOWLY ON 82757 AND, MORE NOTICEABLY, 81470.

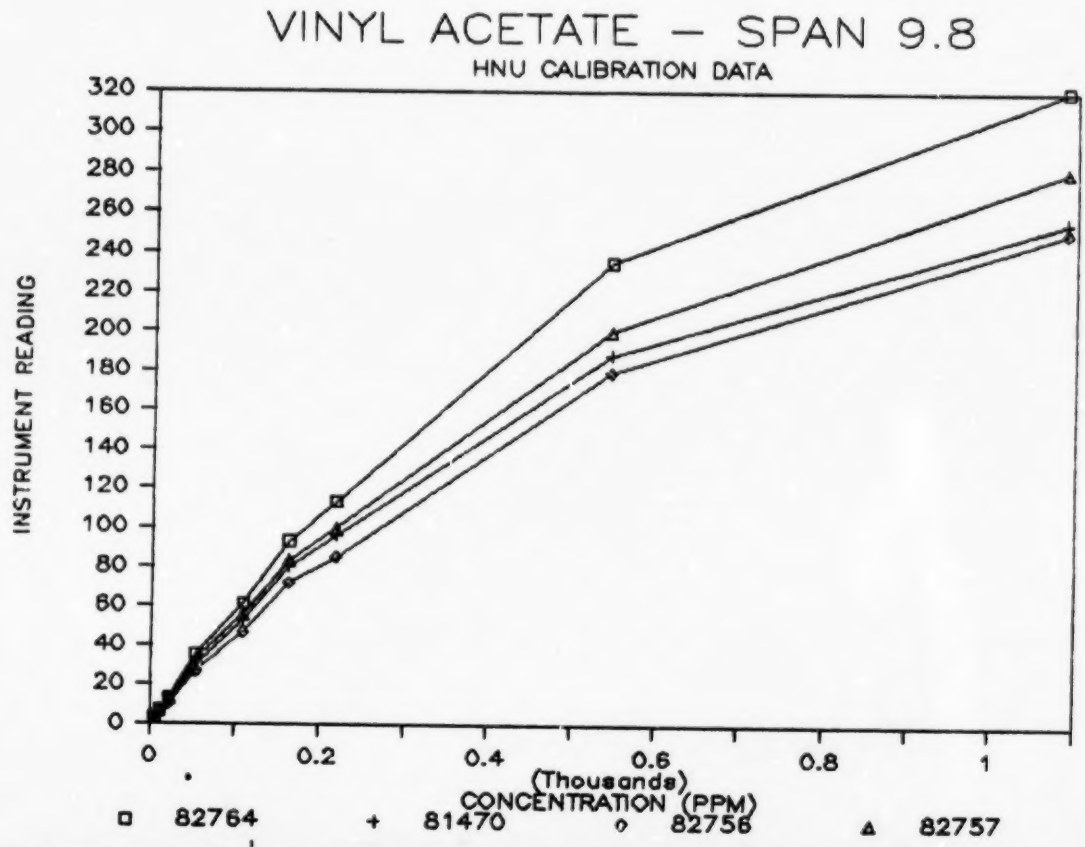
VINYL ACETATE - SPAN=9.8 HNU CALIBRATION DATA

SAMPLE : KODAK, PRACTICAL GRADE
DATE : 19 DECEMBER, 1984
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	13.6	11.7	10.2	12.9	
10.0	14.0	11.5	10.2	12.8	
101	*121	102	91	104	
508	445	350	350	380	
SAMPLES					
5.5	3.7	3.4	2.8	3.5	3.7 (t=6)
10.9	7.4	6.3	5.4	6.8	7.1 (t=8)
22	13.2	11.3	9.8	12.4	13.1 (t=8)
55	36	30	27	33	34 (t=7)
109	62	53	47	56	61 (t=8)
163	93	80	72	83	91 (t=8)
218	113	96	85	100	112 (t=11)
545	235	188	179	200	230 (t=9)
1089	320	255	250	280	315 (t=7)

NOTE : * 11 % INCREASE OVER READING OF FRIDAY, DECEMBER 16. INCREASE IS 22 % OVER DECEMBER 15.


TURPENTINE – SPAN 9.8
HNU CALIBRATION DATA
INSTRUMENT READING
400
350
300
250
200
150
100
50
0
0
200
400
600
CONCENTRATION (PPM)
82764
81470
82756
82757


VINYL ACETATE – SPAN 9.8
HNU CALIBRATION DATA
INSTRUMENT READING
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
0
0.2
0.4
0.6
0.8
1
(Thousands)
CONCENTRATION (PPM)
82764
81470
82756
82757

VINYL CHLORIDE - SPAN = 9.8 HNU CALIBRATION DATA

SYNONYMS : CHLOROETHENE, CHLOROETHYLENE
SAMPLE : SCOTT, 1000 ppm +2% IN AIR
DATE : 9 DECEMBER, 1983
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	11.2	10.9	10.3	12.0	
10.0	11.2	10.8	10.3	12.4	
101	96	99	93	106	
SAMPLES					
5.0	2.1	2.0	1.8	2.3	2.0 (t=8)
10.0	3.7	3.5	3.4	4.2	3.7 (t=8)
15	5.3	5.1	4.9	6.0	5.2 (t=8)
25	8.4	8.2	8.0	9.7	8.3 (t=10)
50	16.7	16.6	16.0	19.2	16.4 (t=9)
75	25	25	24	27	25 (t=8)
100	32	33	31	37	32 (t=8)

NOTE : PRIOR TO START, INTERNAL ADJUSTMENT ON 82764 AND 81470 SET TO READ 96 FOR 101 ppm BENZENE.

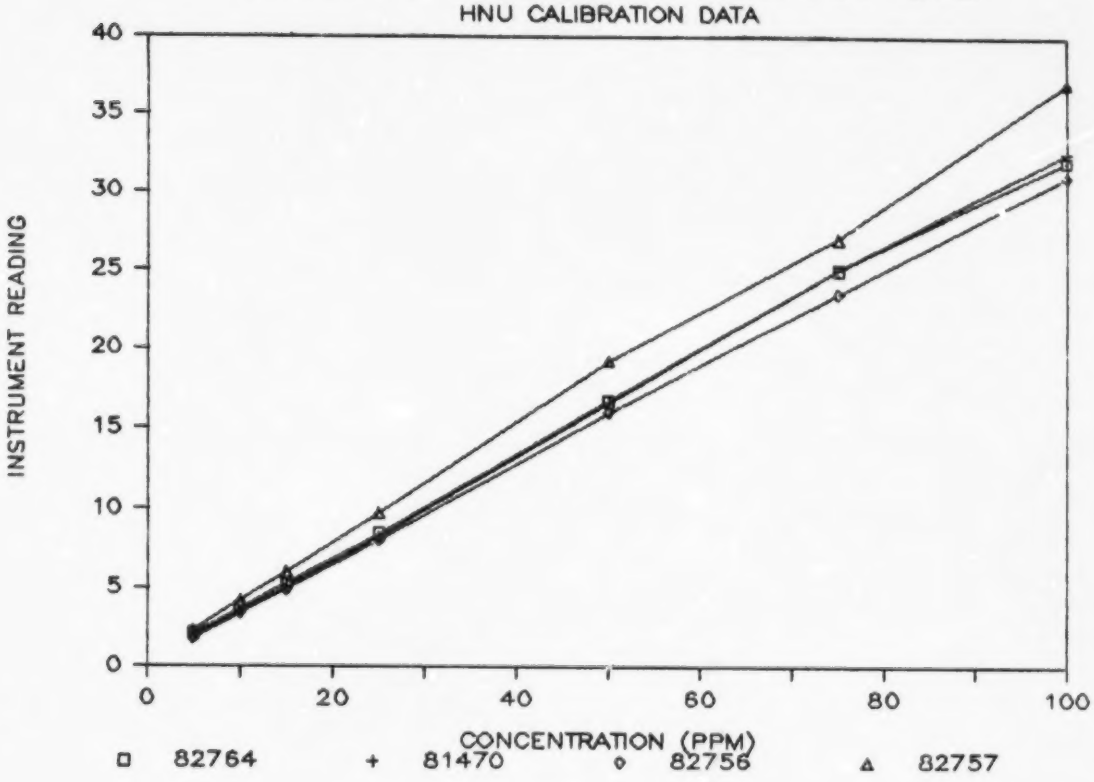
VINYL CHLORIDE - SPAN = 4.9 HNU CALIBRATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
10.0	22.0	22.0	18.9	23.0	
101	175	192	170	196	
SAMPLES					
5.0	3.8	3.6	3.3	4.0	
10.0	6.7	6.6	6.1	7.5	
15	9.4	9.5	8.8	10.8	
25	15.3	15.7	14.5	17.9	
50	32	33	---	36	
75	45	46	43	49	
100	58	61	56	67	

NOTE : READINGS WERE FIRST TAKEN WITH SPAN=9.8, THEN SPAN ADJUSTED TO 4.9 WITH SAMPLE BAG STILL ATTACHED.

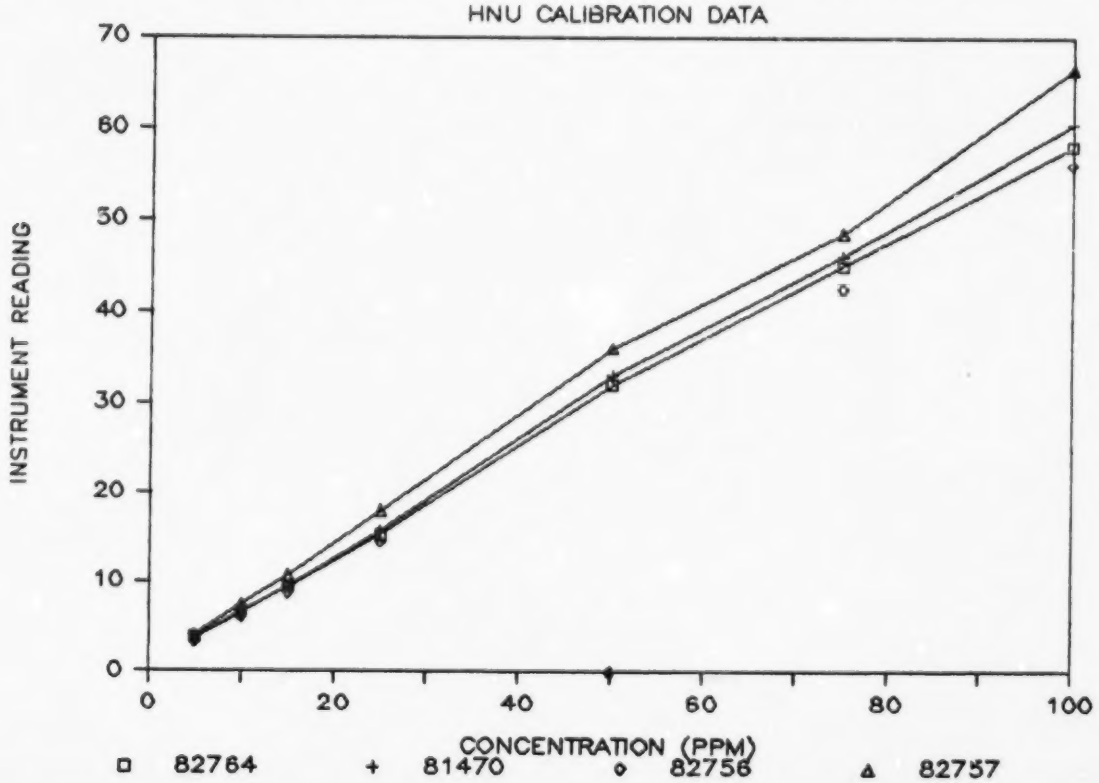
VINYL CHLORIDE — SPAN 9.8

HNU CALIBRATION DATA



VINYL CHLORIDE — SPAN 4.9

HNU CALIBRATION DATA

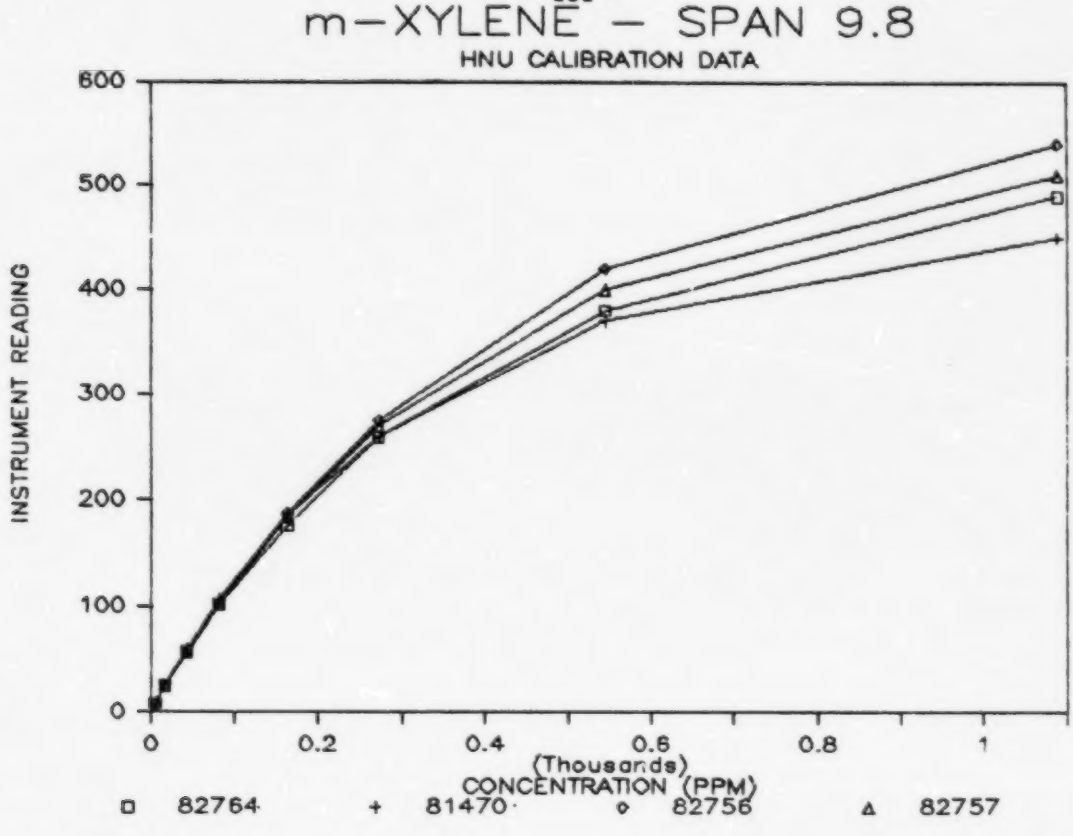


m-XYLENE - SPAN=9.8 HNU CALIBRATION DATA

SYNONYM : 1,3-DIMETHYL BENZENE
SAMPLE : J.T. BAKER, "BAKER" GRADE
DATE : 20/21 DECEMBER, 1983
SEE OVA CALIBRATION DATA SHEET FOR SAMPLE PREPARATION DATA

BENZENE STANDARDS ppm (v/v)	SERIAL NO. 82764	SERIAL NO. 81470	SERIAL NO. 82756	SERIAL NO. 82757	REPEATED @ t=x (min.) SERIAL NO. 82764
0.0	0.0	0.0	0.0	0.0	
101	96	96	95	96	
10.0	11.0	10.9	10.6	11.9	
101	95	98	95	95	DEC. 20, 1983
101	94	96	95	98	DEC. 21, 1983
508	340	340	360	350	
101	93	97	95	94	
SAMPLES					
5.5	8.0	8.2	7.7	8.5	7.9 (t=13)
16.4	25	25	25	26	25 (t=8)
44	57	60	58	59	58 (t=10)
82	102	107	105	102	100 (t=11)
163	175	185	187	184	175 (t=9)
272	260	260	275	270	260 (t=7)
545	380	370	420	400	380 (t=9)
1089	490	450	540	510	490 (t=3)

NOTES : SAMPLE DATA - FIRST 4 CONCENTRATIONS RUN DEC. 20, SECOND 4 RUN DEC. 21. PRIOR TO START, INTERNAL ADJUSTMENT OF ALL INSTRUMENTS TO READ 96 AT 101ppm BENZENE. 82757 REQUIRED UPWARD ADJUSTMENT FROM 88 BEFORE CONTINUATION ON DEC. 21.


m-XYLENE - SPAN 9.8
HNU CALIBRATION DATA
INSTRUMENT READING
600
500
400
300
200
100
0
0
0.2
0.4
0.6
0.8
1
(Thousands)
CONCENTRATION (PPM)
□ 82764
+ 81470
◇ 82756
△ 82757

APPENDIX C

PRIORITY HAZARDOUS SUBSTANCES LIST

Proceedings of the Technical Seminar
on Chemical Spills, Toronto, 1983.
Environment Canada publication

LIST OF PRIORITY HAZARDOUS MATERIALS FOR THE
ENVIRONMENTAL EMERGENCY BRANCH
The 50 Highest Priority Chemicals
(In Alphabetical Order)

Acetic Acid
Acetic Anhydride
Ammonia
Ammonium Nitrate
Ammonium Phosphates
Benzene
Butyraldehydes
Calcium Chloride
Calcium Oxide/Hydroxide
Carbon Dioxide
Chlorine
Cyclohexane
Ethylbenzene
Ethylene
Ethylene Dichloride (1,2-Dichloroethane)
Ethylene Glycol
Ethylene Oxide
Ferric Chloride
Formaldehyde
Hydrogen Chloride/Acid
Hydrogen Fluoride/Acid
Hydrogen Sulfide
Mercury
Methanol
Morpholine
Naphtha
Natural Gas
Nitric Acid
Phenol
Phosphoric Acid
Phosphorous
Potash (Potassium Chloride)
Propylene
Propylene Oxide
Sodium Chlorate
Sodium Chloride
Sodium Hydroxide
Sodium Hypochlorite
Sodium Sulfate
Styrene (Monomer)
Sulfur Dioxide
Sulfuric Acid (and Oleum)
Sulfur
Tetraethyl Lead
Toluene
Urea
Vinyl Chloride
Xylenes
Zinc Sulfate
2-Ethylhexanol

THE SECOND GROUP OF PRIORITY CHEMICALS

(100 substances or groups)

Acetone
Acetylene
Acrylonitrile
Adipic Acid
Aluminum Chloride
Aluminum Hydroxide
Aluminum Sulfate
Aminocarb Pesticide (Matacil)
Ammonium Chloride
Ammonium Sulfate
Arsine
Barium Sulfate
Benzoic Acid
Borax
Boric Acid
Butanols
Butylene
Calcium Carbide
Calcium Carbonate
Calcium Hypochlorite
Calcium Phosphate
Caprolactam
Carbaryl
Carbofuran Pesticides
Carbon Disulfide
Carbon Tetrachloride
Chlordane
Chloroform
Copper Sulfate
Cresols
Dicamba
Dichlorobenzene
Dimethyl Ether
Dimethyl Terephthalate
Dinoseb
Diphenylmethane-4,4'-Diisocyanate
Ethanolamine
Ethanol
Ethylene Dibromide
Fenitrothion
Fluorochloromethanes
Formic Acid
Hydrazine
Hydrogen Peroxide
Hydrogen
Ispropanol
Ispropylbenzene
Latex
Lead Chromate
Lead Oxides
Magnesium Hydroxide
Malathion
Maleic Anhydride
Methyl Ethyl Ketone
Methyl Isobutyl Ketone
Methyl Methacrylate
Methylamines
Methylene Chloride
MCPA
n-Hexane
Nitrilotriacetic Acid
Nitroglycerine
Nonyl Phenol
PCBs
Pentachlorophenol
Pentaerythritol
Perchloroethylene
Phthalic Anhydride
Potassium Hydroxide
Potassium Sulfate
Propylene Glycols
Sodium Aluminate
Sodium Arsenite
Sodium Borohydride
Sodium Carbonate
Sodium Cyanide
Sodium Dichloroisocyanurate
Sodium Dichromate
Sodium Hydrosulfite (Dithionite)
Sodium Phosphates
Sodium Silicates
Sodium Sulfite
Sulfuryl Chloride
Tall Oil
Terephthalic Acid
Terphenyls
Titanium Dioxide
Triallate Pesticides
Trichlorfon Pesticides
Trifluralin Pesticides
Trinitrotoluene
Turpentine
Vinyl Acetate
Yellow Cake
Zinc Chloride
Zinc Oxide
1,1,1-Trichloroethane
1,3-Butadiene
2,4-D (2,4-Dichlorophenoxyacetic Acid)
2,4-Toluene Diisocyanate

POOR

QUALITY

ORIGINAL